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Processing of DMSP Magnetic Data: Handbook of Programs, Tapes and Datasets

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Processing of DMSP Magnetic Data: Handbook of Programs, Tapes and Datasets

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Abstract

The DMSP F-7 satellite was an operational Air Force meteorological satellite which carried a magnetometer for geophysical measurements. The magnetometer was located within the body of the spacecraft in the presence of large spacecraft fields. In addition to stray magnetic fields, the data have inherent position and time inaccuracies. Algorithms were developed to identify and remove time varying magnetic field noise from the data. These algorithms are embodied in an automated procedure which fits a smooth curve through the data and then identifies outliers and which filters the predominant fourier components of noise from the data. Techniques developed for Magsat were then modified and used to attempt determination of the spacecraft fields, of any rotation between the magnetometer axes and the spacecraft axes, and of any scale changes within the magnetometer itself. Software setup and usage are documented and program listings are included in the Appendix. The initial and resulting data are archived on magnetic cartridge and the formats documented.

CONTENTS

I. Introduction

The DMSP F7 spacecraft was launched on 18 Nov, 1983 into a 98.74 degree inclination orbit, with apogee 844 km altitude and perigee 822 km. (Rich, 1984). The primary purpose of the spacecraft was to obtain tropospheric meteorological data. However, a triaxial fluxgate magnetometer was included on the spacecraft in order to monitor the geophysical environment. This report is the second of two dealing with the examination of these magnetometer data to evaluate their usefulness in describing the earth's core-produced geomagnetic field. The first report "Processing of DMSP Magnetic Data and its Use in Geomagnetic Field Modeling" (Ridgway et. al, 1989), henceforth referred to as paper 1, gave an overall summary of the processing methods and results and of the field modeling efforts. Some of the material in that report is duplicated in the present document. However the emphasis in this document is to describe the software utilized, the crucial data sets and the processing procedures. All pertinent data sets, code, JCL, etc. are stored on magnetic cartridge, as documented herin.

The DMSP F7 magnetometer was mounted on the satellite body, as opposed to being attached to a boom, because of spacecraft engineering constraints (Rich, 1984). The magnetometer, a triaxial fluxgate, was aligned with the spacecraft X, Y and Z axes, which are defined as follows: X is vertically down, Y is along-track and Z is cross-track. The three sensor units were built by the Schonstedt Instrument Co., Reston, VA, in the 1960s. The electronics unit for the magnetometer was built by the Applied Physics Laboratory of Johns Hopkins University, Laurel, MD, based on the design of the MAGSAT fluxgate magnetometer.

The magnetometer acquired field measurements at a rate of 20 samples per second. Measurements were in the form of counts, with one count equalling 12 nano-Teslas (nT). According to Rich (1984), the instrument was not intended to survey the main geomagnetic field, so it was not calibrated with high accuracy on the ground, nor recalibrated in orbit.

Because of the close proximity of the magnetometer to on-board electronic instrumentation, its data were contaminated by non-random instrumental noise, with magnitudes of up to several thousand nT. The attitude of the spacecraft was measured to an accuracy of about 0.1 degree, or 360 arc-seconds. While this attitude accuracy is not as good as that obtained with MAGSAT, in principle it is of sufficient accuracy to enable meaningful vector measurements. In the absence of other near-Earth satellite magnetic field data for this time period, and in view of the success of methods used on MAGSAT to solve for spacecraft fields, it was decided to investigate the possibility of processing the DMSP F7 data to a stage where they may be useful for main field modeling.

II. Transformation of On-tape Data to Magnetic Readings.

The magnetometer data contained on the basic DMSP data tapes received from the Air Force is in the form of magnetometer counts, which must be converted into field values in nT in order to be useful. Data is arranged

on the tape as a header, containing time and position information for each minute of operation, followed by 60 magnetometer readings (1 per second). See description of tape format in Section VII. All times on the data are rounded to the nearest second. All positions on the original Air Force data are expressed in nautical miles, rounded down to the nearest nautical mile. Nautical miles were converted to kilometers (one nautical mile equals about 1.8 km) in subsequent data processing.

20 readings per second for each of the magnetometer X, Y and Z axes were originally recorded by DMSP, although only readings #1 and #11 were written on the tapes sent to the Geology and Geomagnetism branch at Goddard. For the Goddard main field studies, only the magnetometer reading associated with the header record was utilized. This preserved sufficient data density (one reading per minute) to fully describe the main geomagnetic field.

The magnetometer was calibrated prior to launch at the NASA Goddard Space Flight Center magnetic test chamber with the following results (Rich, 1984):

1) Measurement (nT) = Calibration Matrix (nT/count) * Measurement (counts) + Bias (nT)

$$\begin{array}{r} \text{(radial)} \\ \text{(along-trk)} \\ \text{(cross-trk)} \end{array} \begin{pmatrix} B_x \\ B_y \\ B_z \end{pmatrix} = \begin{pmatrix} 12.1001 & -0.0055 & 0.0193 \\ -0.0247 & 12.1863 & -0.0101 \\ 0.0069 & 0.0232 & 12.1735 \end{pmatrix} * \begin{pmatrix} C_x \\ C_y \\ C_z \end{pmatrix} + \begin{pmatrix} -0.0653 \\ 59.8733 \\ 39.4228 \end{pmatrix}$$

This equation is used to compute the magnetic field in spacecraft coordinates in nT, given a reading in magnetometer counts. However, this calibration does not take into account the field from the spacecraft, which adds greatly to the bias vector. This vector must be determined from in-flight data. Later work using the FIT program (see Field Value corrections) accomplished this, and re-determined the bias vector as: (89nT, 8457nT, -1441nT) for radial, along-track and cross-track measurements, respectively. These values are still somewhat approximate and require small corrections discussed in paper 1. In addition, for computational ease, it was decided to redefine the spacecraft system to be compatible with the MAGSAT coordinate system, so that the spacecraft X axis is defined as cross-track, Y is radially down and Z is along-track. The correct transformation of DMSP magnetometer counts to nano-teslas in spacecraft coordinates compatible with MAGSAT is thus:

2) Measurement (nT) = Calibration Matrix (nT/count) * Measurement (counts) + Bias (nT)

$$\begin{array}{r} \text{(cross-trk)} \\ \text{(radial)} \\ \text{(along-trk)} \end{array} \begin{pmatrix} B_x \\ B_y \\ B_z \end{pmatrix} = \begin{pmatrix} 0.0069 & 0.0232 & 12.1735 \\ 12.1001 & -0.0055 & 0.0193 \\ -0.0247 & 12.1863 & -0.0101 \end{pmatrix} * \begin{pmatrix} C_x \\ C_y \\ C_z \end{pmatrix} + \begin{pmatrix} -1441 \\ 89 \\ 8457 \end{pmatrix}$$

All data discussed in the remainder of this report are assumed to have been processed through this equation and have units of nT. The (B_x, B_y, B_z) measurement vector in equation #2 will henceforth have the label **Bspu**, meaning the vector is in MAGSAT spacecraft coordinates and not yet processed through the final corrections.

III. Field Value Corrections.

According to Rich (1984), the DMSP magnetometer may be misaligned relative to the spacecraft by as much as 0.5 degree per axis, with the misalignment measured to an accuracy of about 0.1 degree. Also, bending of the spacecraft body may result in further misalignment. In addition, the values of the three magnetic components may be in error by a fixed bias or by a multiplying factor. The FIT program has the capability to solve for corrections in these parameters in conjunction with the least squares main field solution. The theory of this adjustment is as follows (see also Estes, 1983):

The FIT program computes three types of adjustments to vector satellite magnetometer data: 1) A diagonal calibration matrix containing "slope" parameters, which is multiplied times the measured vector to correct for magnetometer drift, 2) a bias correction vector which is subtracted from the measured vector to correct for constant magnitude offsets, and 3) a rotation matrix which is multiplied times the measured vector to correct for angular offsets of the magnetometer from ideal satellite coordinates. These adjustment parameters are applied to the measured uncorrected data in spacecraft coordinates according to the equation:

3) Bspc = TSM * TCAL * (Bspu - **bias**)

where: **Bspu** is the uncorrected measurement vector in spacecraft coordinates, as given in equation 2).
Bspc is the corrected measurement vector in spacecraft coordinates.
bias is a vector of magnetometer bias corrections in addition to those given in equation 2).
TCAL is the calibration correction matrix of slope parameters.
TSM is the rotation correction matrix.

The elements of **bias** are: (BS_1, BS_2, BS_3), where BS_i are component biases derived in the FIT program, with values derived and discussed in paper 1.

TCAL has elements:

$$\begin{pmatrix} 1/SL_1 & 0 & 0 \\ 0 & 1/SL_2 & 0 \\ 0 & 0 & 1/SL_3 \end{pmatrix}$$

where SL_i are slopes derived in the FIT program. SL_1 and BS_1 are applied to the satellite X axis, SL_2 and BS_2 to satellite Y axis, and SL_3 and BS_3 to the satellite Z axis components.

The elements of TSM are based on three Euler angles (ϵ_x, ϵ_y, and ϵ_z) solved in execution of the FIT program. (<u>Note</u>: In the FIT program, as of 2/28/88, ϵ_x is denoted ϵ_2, ϵ_y is denoted ϵ_1, and ϵ_z is denoted ϵ_3.) Using the notation TSM_{ij}, where i is the matrix row and j the matrix column, these are:

4)

$$\begin{aligned}
TSM_{11} &= \cos\epsilon_y*\cos\epsilon_z \\
TSM_{12} &= \cos\epsilon_y*\cos\epsilon_x*\sin\epsilon_z + \sin\epsilon_y*\sin\epsilon_x \\
TSM_{13} &= -\cos\epsilon_y*\sin\epsilon_x*\sin\epsilon_z + \sin\epsilon_y*\cos\epsilon_x \\
TSM_{21} &= -\sin\epsilon_z \\
TSM_{22} &= \cos\epsilon_x*\cos\epsilon_z \\
TSM_{23} &= -\sin\epsilon_x*\cos\epsilon_z \\
TSM_{31} &= -\sin\epsilon_y*\cos\epsilon_z \\
TSM_{32} &= \cos\epsilon_y*\sin\epsilon_x - \sin\epsilon_y*\sin\epsilon_z*\cos\epsilon_x \\
TSM_{33} &= \cos\epsilon_y*\cos\epsilon_x + \sin\epsilon_y*\sin\epsilon_x*\sin\epsilon_z
\end{aligned}$$

The TSM matrix in the FIT program is derived from 3 rotation matrices (denoted R_x, R_y, R_z) in the spacecraft coordinate system. R_x is a left-handed rotation through the angle ϵ_x, about the spacecraft X axis. R_y is a left-handed rotation about the spacecraft Y axis, with angle of rotation ϵ_y. R_z is a right-handed rotation through the angle ϵ_z, about the spacecraft Z axis.

The matrices R_x, R_y and R_z are thus

$$5) \qquad R_x = \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos\epsilon_x & -\sin\epsilon_x \\ 0 & \sin\epsilon_x & \cos\epsilon_x \end{pmatrix} \qquad R_y = \begin{pmatrix} \cos\epsilon_y & 0 & \sin\epsilon_y \\ 0 & 1 & 0 \\ -\sin\epsilon_y & 0 & \cos\epsilon_y \end{pmatrix}$$

$$R_z = \begin{pmatrix} \cos\epsilon_z & \sin\epsilon_z & 0 \\ -\sin\epsilon_z & \cos\epsilon_z & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

Rotations provided by R_x, R_y and R_z are illustrated in Figures 1a), b) and c) in paper 1.

TSM is created by rotating about the X axis first, then about Z, then about Y, e.g.,

$$6) \qquad TSM = R_y * R_z * R_x$$

An older version of the FIT program, documented in Estes (1983), used a different order of rotation, about the Z axis first, about the new X axis second, and finally about the new Z axis. It is now known that this Z-X-Z rotation order fails to adequately resolve the first and third angles when they are large, and so the present order of rotation was instituted, with successful results.

The relation of euler angles ϵ_x, ϵ_y, ϵ_z to "roll, pitch, yaw" notation is dependent on the spacecraft axis designations. For example, since the MAGSAT Z-axis is pointed in its along-track direction, ϵ_z is roll, ϵ_y(radial) is yaw, and ϵ_x(cross track) is pitch.

The FIT program calculates some field quantities in earth-fixed cartesian coordinates. The coordinate origin is at earth's center; the X axis points along 0° longitude; the Y axis points along 90° meridian; and the Z axis points along the geographic north pole. Information is therefore required on the relation between the corrected spacecraft measurement vector, Bspc, and its analog in earth-fixed coordinates Bef, for every data point. This information is contained in transformation matrix TGS:

$$7) \qquad Bef = TGS * Bspc$$

The TGS matrix itself is an approximation computed from the formula:

$$\text{8)} \qquad TGS = \begin{pmatrix} -n_x & -r_x & v_x \\ -n_y & -r_y & v_y \\ -n_z & -r_z & v_z \end{pmatrix}$$

where: $r_x = \cos\phi\cos\lambda$, $r_y = \cos\phi\sin\lambda$, $r_z = \sin\phi$

$n_x = \cos\phi_n\cos\lambda_n$, $n_y = \cos\phi_n\sin\lambda_n$, $n_z = \sin\phi_n$

$v_x = n_y r_z - r_y n_z$, $v_y = n_z r_x - r_z n_x$, $v_z = n_x r_y - r_x n_y$

ϕ, λ, ϕ_n and λ_n are defined as:

ϕ = Geocentric latitude

λ = East longitude

ϕ_n = -8.74°, the inclination of the vector normal to the orbit

$\lambda_n = \lambda \pm \arccos[-\tan(\phi_n)*\tan(\phi)]$, where + is used for a descending orbit (N to S) and - for an ascending orbit.

It should be noted that this equation is not accurate for latitudes greater than about 75°. DMSP data between 75° and 81.26° were therefore not utilized in subsequent analyses. Derivation of this restriction and of the TGS transformation elements themselves may be found in Appendix B of paper 1.

Combining equations #3 and #7 yields:

$$\text{9)} \qquad \mathbf{Bef} = TGS * TSM * TCAL * (\mathbf{Bspu} - \mathbf{bias})$$

Bspu and TGS are read or computed from input data, and TSM, TCAL and **bias** are solved for in execution of the FIT program.

IV. Noise Sources in the Magnetic Data.

The DMSP data were examined initially by Rich (1984), who found three sources of magnetic noise. The first two are high frequency sinusoidal signals with periods of 0.576 and 3.456 seconds. These are caused by the rotating X-ray scanner, designated the SSB/S instrument, which is mounted 10 to 15 inches from the magnetometer sensors and generates a small magnetic field. These high frequency noise sources are of magnitude less than about 30 nT and are not a concern in the present study.

The third noise source found by Rich is the operation of the satellite torquing coils. These are turned on for durations of about 4 minutes at various times throughout the DMSP mission. When the coils are on, the magnetic field data is offset by a constant level shift of 3000 to 14,000 nT. This type of noise is screened out by the "gross outlier" criterion for reducing the data.

A fourth known noise source consists of fields in the 100 - 150 nT range which result from turning on transmitters and tape recorders when over a tracking station. It is assumed that most data so affected will be eliminated in the various outlier tests.

A noise source not discussed by Rich(1984) was discovered by examining orbital plots of residual data, i.e. data which have had a preliminary field model subtracted. These residual data show strong periodic trends with amplitudes of up to 70 nT, after other corrections were applied. An in-depth discussion of this periodic noise and its removal is found in paper 1.

V. Automated Clean-Up Procedure for DMSP Data.

Preliminary field modeling

A test model was generated from DMSP data at epoch 1984.04. The g_1^0 term from this model equaled -29,900.4 nT. A model derived from observatory data at the same epoch yielded g_1^0 equal to -29,883.4. The closeness of the two terms suggests the apparent adequacy of the DMSP data for main field modeling. A calibration of the 1984.04 data, using the second procedure described in the previous section, was also executed with the following results: SL1 = 0.9955, SL2 = 0.9996, SL3 = 1.0025. The nearness of these values to unity again suggests that the DMSP magnetometer measured the magnetic field accurately for that selection of data. These results indicated that DMSP data might be useful for main field modeling, in spite of the large spacecraft fields. All of these studies were conducted using only a few days of data. On the basis of these results, it was decided to proceed with a larger quantity of data.

The preliminary field model was removed from January 14-18 DMSP data to create residual data. Upon examination, these orbits of data showed strong periodicities. A spectral decomposition of the data revealed noise sources with periods equal to the orbit period (100 minutes) and subharmonics of 1/2, 1/3 and 1/4 of the orbit period. Figure 1 displays a typical residual orbit from this time period. The X and Y components most clearly demonstrate this periodic noise. Figure 2 is the associated spectrum. Peaks in the spectrum display these dominant noise periods quite noticeably. As will be seen below, one cause of the periodic noise is the need for adjustment of the Euler angle values in the TSM matrix in equation 3). The other causes of this periodic noise is unknown. The peak-to-peak amplitude of the noise is about 300 nT before Euler angle correction and about 50-70 nT after that correction.

Automated procedure description

A five-stage clean-up procedure was followed to remove data spikes and periodic noise from the DMSP data. In this procedure the data were processed through a data cleaning and filtering program written by T.J. Sabaka called FILTER. The stages are as follows: 1) Fit a span of DMSP data, covering several days, with a preliminary field model. Subtract the field model to get residual data. Reject data points above 75° absolute latitude, and reject "gross outliers", i.e., residual data with absolute values greater than a specified cutoff. Fit the residual data with a spline function and reject points which deviate more than 2 standard deviations from that function. 2) Add residual data which is not rejected back to the preliminary field model. Then fit a new field model to this data with epoch equal to the average time of that data span. Solve for constant main field coefficients, magnetometer angle adjustments and biases. 3) The new field model is reformatted for further use. 4) Correct the original data with the angle and bias solutions. Use the computed field from stage #3 to re-create the residual data, and re-do step #1, i.e. reject gross outliers and spline outliers. 5) Fit a Fourier function, which is composed of the 4 dominant noise periods (25 minutes, 33 minutes, 50 minutes and 100 minutes) in a least-squares manner to the residual data. Reject outliers according to the Fourier fit, using the 2σ criterion as for the spline fit. Then subtract the Fourier function from the data. Add the result back to the computed field model from step #2, to create the final, corrected data set.

Stage 5) is somewhat ad hoc. Such periodic variations could arise from source corrections we have either overlooked or been unable to apply. For example, comparison of Figures 3a and 3b shows that much of the large periodic oscillation results from unadjusted Euler angles. It is both more meaningful and reliable to correct the euler angles than to remove the variations via the Fourier fit. For this reason the ad hoc Fourier fit correction is applied last.

Figure 3 shows the same profile from Figure 2, after it has undergone the data cleaning process. Most of the periodic noise is gone, and the major spikes and outliers have been removed.

Table 1 summarizes the five stages. The input and output files are indicated for each stage.

TABLE 1: FIVE STAGE CLEAN-UP PROCESS

NAME	INPUT FILE	OUTPUT FILE	DESCRIPTION
(DTAPE.PROCESS) STAGE 1	1)A.F.Tape DATE 2)DATA.MISC (CAL84FID) 3)XRTJS.BSPINFO.DATA 4)XRTJS.DMSP.STEP2.DATA " " " 3 " " " " 4 " " " " 5 "	DATE.STEP1.OUTBIN (VBS,lrecl=11204, Blksize=22412)	Translates magnetometer counts to nT. Fits residual orbits with a B spline, and flags outliers and points with non-determinable velocities. Puts data into FIT binary format.
STAGE 2	DATE.STEP1.OUTBIN	DATE.STEP2.COEFFS	Fits a field model to flagged data. Solves for magnetometer corrections (euler angles, magnetometer biases).
STAGE 3	DATE.STEP2.COEFFS	DATE.STEP3.COEFFS	Reformats field model.
STAGE 4	Same as STAGE 1 except DATE.STEP3.COEFFS is used in place of DATA.MISC(CAL84FID).	DATE.STEP4.OUTF (FB, lrecl=240, Blksize=4800)	Same function as STEP1, but with a different field model.
STAGE 5	DATE.STEP4.OUTF, plus same files as STEP4.	1)DATE.STEP5.OUTF 2)DATE.STEP5.OUTBIN	Fits orbits with periodic fourier function, and removes this function from data. Data is output both in formatted and binary (FIT) formats.

(Note: STEP1,STEP4,STEP5 utilize load module XRJRR.SATFILT, which contains the FILTER program. STEP2 utilizes module XRJRR.FIT.DMSP.LOAD2, which contains the old FIT program.)

The output from STAGE1, DATE.STEP1.OUTBIN, is not saved.
The output from STAGE2, DATE.STEP2.COEFFS, becomes file 1 on the output tape.
The output from STAGE3, DATE.STEP3.COEFFS, becomes file 2 on the output tape.
The output from STAGE4, DATE.STEP4.OUTF, becomes file 3 on the output tape.
The output from STAGE5, DATE.STEP5.OUTBIN, becomes file 4 on the output tape.
The output from STAGE5, DATE.STEP5.OUTF, becomes file 5 on the output tape.

Use of the FILTER Program

As noted, the five stages of the cleanup procedure are based on the program FILTER. Filter is comprised of five steps, each modularly designed. [Not to be confused with the "stages" in Table 1 and accompanying text.]

STEP 1: Involves reading of an original satellite magnetic data tape and transforming the raw magnetometer counts to magnetic field values in the spacecraft coordinate system.

STEP 2: Involves the location and padding of time gaps in the data and the determination of the direction of the spacecraft velocity vector at each measurement location.

STEP 3: Involves the transformation of the magnetic field measurements from spacecraft to topocentric coordinate system from which residual measurements are determined from a given field model. Data locations at which any vector residual exceeds the specified tolerance are flagged as outliers.

STEP 4: Involves fitting a trend to the magnetic field residuals with B-Splines and/or fourier waveforms, with the option of flagging points whose trend residuals exceed a given tolerance and the option of detrending the original data.

STEP 5: Involves outputting a final modified satellite magnetic tape in three basic forms:

1) EBCDIC tape in topocentric coordinates
2) EBCDIC tape in desired spacecraft coordinates
3) Binary tape in old fit program format (Magsat convention)

Program FILTER may run in one of four modes indicated by the input variable IMODE:

IMODE = 0: Perform steps 1, 2, 3, 4, and 5.
IMODE = 1: Perform steps 4 and 5.
IMODE = 2: Perform step 4.
IMODE = 3: Perform steps 1, 2, 3, and 4.

The reader will note that program FILTER is very general. It use in processing DMSP data is a special case.

The correspondence between IMODE and the STAGE's of Table 1 is as follows:
STAGE 1: IMODE = 0
STAGE 4: IMODE = 0
STAGE 5: IMODE = 1

STAGE 2 consists of running the old version of the FIT (Main Field Modeling) Program. For future work, this step must be modified to use the new FIT program.

STAGE 3 is a simple program which modifies the format of the SHA coefficients output from STAGE 2. When output they are in the standard format for the old FIT program. This stage converts the coefficients into the format needed by the program FID. FID is the standard program to compute magnetic field at a specified time and location from a set of SHA coefficients.

Automated Procedure Deck Setup

Typical setup (JCL) decks, annotated, for the five stages are as follows:

A. For STAGE's 1, 4, and 5, using program FILTER:

In these listings XRJRR.SATFILT is the location of the load module for the FILTER program. The source code is presently in XRTJS.DMSP.FILT.CNTL. In the future both, as well as the run decks printed on the next few pages, will be saved on a cartridge. Details will be given later in this report.

SATFILT is a combination of the basic programs FILTER and BSPLYN3, with slight modifications for use with DMSP data. These modifications have to do with data plotting. The original programs produced plot output for use in the WOLFPLOT plotting package. The modifications permit plotting using the DIUTIL plot package. The modifications are used in conjunction with program ADDFLAG whose purpose is to create an ASCII file from program FILTER output which has both a residual field (core model subtracted) and a B-spline fit to that field, versus time in minutes, for one orbit. Points which are outliers from the B-spline fit are flagged. INOTE is the flag. When a data point has a value of INOTE of 1, 2, or 6, the data point is not output. The code to produce the plotting output requires the following code additions:

In BSPLOT:

```
**********************************************************************
      CHARACTER*1 SYMBOL(5), BLANK
      DATA BLANK /' '/
**********************************************************************
```

After the following CODE, place the CODE between the asterisks:

```
26     CALL OGRID(XMIN,XMAX,LINT,IXFMT,1,PMIN,PMAX,MINT,IYFMT,2,0)
      IF(II.EQ.1) CALL PLOT(XS,SS,NOBS,'X')
      CALL PLOT(XS,VS,NOBS,' ')
**********************************************************************
      WRITE(25,665)
 665   FORMAT(1X,'RAW DATA (FIRST) AND B-SPLINE FIT')
      DO 31 KKK=1,NOBS
 31    WRITE(25,666)XS(KKK),SS(KKK),VS(KKK)
      WRITE(25,667) BLANK
 666   FORMAT(3F10.3)
 667   FORMAT(A1)
**********************************************************************
      DO 59 JL=1,LTYPER
      NKNT=KK(JL)
```

This code outputs to unit 25, which should be allocated in the JCL as a fixed-block ASCII file. After FILTER has been run and the output of unit 25 saved, ADDFLAG should be run.

```
Inputs to ADDFLAG: Unit 10 - file created by FILTER unit 25
                   Unit 15 - file created by FILTER unit 15
                             =DATE.STEP4.OUTF
```

Output from ADDFLAT: Unit 20. Another fixed-block ASCII file with format:

```
     Title (72A1)
     Time (min), Residual (nT), B-spline value (nT), Flag - (3F10.3,I5)
     ... Data values repeated N times ...
     Blank line
```

This sequence is repeated three times, one for each component (X, Y, Z).

The ASCII file is plotted with DIUTIL plotting program DPLOT1, which inputs it on unit 8 and outputs a plot file using standard DIUTIL commands.

ADDFLAG2: is a simpler version of ADDFLAG, which outputs an ASCII file of Fourier detrended points after running FILTER, step 5. ADDFLAG2 does not require special code to be inserted into FILTER. It writes out only points with INOTE = 0,3,4,5.

Input to ADDFLAG2: Unit 15 - file created by FILTER unit15 = DATE.STEP5.OUTF.

Output from ADDFLAG2: An ASCII file in the same format as that produced by ADDFLAG and which may be plotted by program DPLOT1.
Note that Unit 10 contains the input DMSP data and that OPTCD=Q means that an ASCII file is expected.

Unit 15 is FILTER output in EBCDIC, in topocentric coordinates. Unit 17 is output in old FIT format, Binary, using Magsat coordinates. Unit 12 is the input field model coefficients and Unit 22 contains B-Spline and Fourier series information.

Other programs related to FILTER and to DMSP data processing are: BSIG, and POWPLT. BSIG calculates the mean and standard deviation of DMSP data relative to a given field model. It also calculates the dipole latitude of the data and will not use data above a specified dipole latitude. It only considers "good" points, i.e. with INOTE =0. It presently compares the DMSP data to the field model values contained on DATE.STEP5.OUTF; however, it may be modified to use an arbitrary field model by removing the comment cards from the section of code which calls the FID program. Inputs are on Unit 8 and Unit 10: Unit 8 is used for field model coefficients in FID format, if using an arbitrary model, otherwise this unit is not needed. Unit 10 = DATE.STEP(1,4,5).OUTF is an ASCII file output from step 1, 4 or 5. The output is in printed format only.

POWPLT is a wolfplot power spectrum plotting routine. It may run on any file which has the correct input format, but was created specifically to plot power spectra output by the following code inserted into program FILTER, subroutine SPECT, following the code before the asterisk:

```
      IF(PLT.EQ.1) CALL PLOT(PERIOD,AMP,LTOTL,' ')
      IF(PLT.EQ.2) CALL PLOT(PERIOD,PHI,LTOTL,' ')
      IF(PLT.EQ.3) CALL PLOT(PERIOD,POWER,LTOTL,' ')
**********************************************************************
      WRITE(26,670)
 670   FORMAT(1X,'PERIOD AND POWER SPECTRUM')
      DO 33 KKK=1,LTOTL
 33    WRITE(26,672)
 671    FORMAT(2E15.8)
 672    FORMAT(' ')
**********************************************************************
C
C PRINT HEADING
```

When FILTER is run with the inserted code, a fixed block ASCII file in the following format is output to unit 26:

Title (A72)
Period Power (2E15.8, repeated N times)
Blank line
>entire sequence repeated three times, once for each component.

This file is then input into POWPLT, which outputs a plot file onto unit 8, which for WOLFPLOT is a plot tape.

Use of Dst. Dst is added to DMSP data for use in the old FIT program. The program which does this is DSTADD. DSTADD requires Dst values in a certain format: (2X, I2, I3, 2X, 24I4), where the first variable is year past 1900, the second is day of year, followed by 24 Dst values for that day. The original data tape containing Dst (TD5696) is not in this format, but must be processed through DST1 (located on DMSP.PROGRAMS) to create a file suitable for input into DSTADD. DST1 also windows DST values according to date.

The functioning of Program FILTER depends on the input variables specified in various NAMELIST statements. The following pages are a Glossary of the various variables that can be set in this manner.

GLOSSARY OF PROGRAM FILTER NAMELIST ITEMS

NAMELIST IOFILE -

IST1 - INPUT UNIT FOR ORIGINAL RAW DATA TAPE(S) IN STEP1.

IST2 - INPUT UNIT IN STEP2, OUTPUT UNIT IN STEP1, MAGNETIC FIELD IN FIT/MAGSAT COORDINATES.

IST3 - INPUT UNIT IN STEP3, OUTPUT UNIT IN STEP2, VELOCITY DIRECTIONS AND PADDED TIME-GAPS.

IST4 - INPUT UNIT IN STEP4, OUTPUT UNIT IN STEP3, MAGNETIC FIELD AND RESIDUALS IN TOPOCENTRIC COORDINATES.

IOR - FILTER INPUT UNIT, SAME AS IST4 IN OPERATION MODE 0 AND 3.

IOW - FILTER OUTPUT UNIT, INPUT UNIT IN STEP5.

IOF - OUTPUT UNIT IN STEP5, FORMATTED MAGNETIC FIELD IN FIT/ MAGSAT OR TOPOCENTRIC COORDINATES DEPENDING ON IBTBS VALUE.

IOD - OUTPUT UNIT IN STEP5, FORMATTED MAGNETIC FIELD IN DESIRED SPACECRAFT COORDINATES.

IOB - OUTPUT UNIT IN STEP5, BINARY MAGNETIC FIELD IN PROGRAM FIT FORMAT.

ISC1 - FILTER SCRATCH UNIT.

ISC2 - FILTER SCRATCH UNIT.

ISC3 - SCRATCH UNIT USED IN SUBPROGRAM DPINFO TO STORE VARIOUS DATA PARAMETERS.

NAMELIST FIELDP -
===============

JJ - FID INPUT POSITION COORDINATES: (0) GEODETIC (1) GEOCENTRIC.

MM - FID EQUITORIAL RADIUS AND RECIPROCAL FLATTENING: (0) DEFAULT AE = 6378.16 KM, FLAT = 298.25 (1) INPUT VALUES.

NMX - MAXIMUM DEGREE OF FID MODEL EVALUATION.

NEXT - EXTERNAL FIELD MODEL: (0) DO NOT EVALUATE (1) EVALUATE.

IOCF - INPUT UNIT IN FID FOR COMPUTED MAGNETIC FIELD MODEL.

IDST - INDUCED FIELD COEFFICIENTS: (0) DO NOT EVALUATE (1) EVALUATE.

DST - DST VALUE.

LL - FID FIELD EVALUATION MODE: (-1) EVALUATE AT OLD TIME (0) EVALUATE (1) READ FIELD MODEL AND EVALUATE.

NAMELIST BSPLIN -
===============

H - ARRAY CONTAINING NUMBER OF INTERNAL KNOTS FOR B-SPLINE FUNCTIONS FITTING X, Y, AND Z COMPONENTS, RESPECTIVELY.

NN - ARRAY CONTAINING ORDER OF B-SPLINE FUNCTIONS FITTING X, Y, AND Z COMPONENTS, RESPECTIVELY.

NT - ARRAY CONTAINING NUMBER OF FOURIER WAVEFORMS FITTING X, Y, AND Z COMPONENTS, RESPECTIVELY.

KA - B-SPLINE INTERNAL KNOT ADJUSTMENT FOR BEST FIT WITH RESPECT TO WEIGHTED RMS: (0) DO NOT ADJUST (1) ADJUST

ITERMX - MAXIMUM NUMBER OF ITERATIONS IN UNIVARIANT SEARCH FOR OPTIMUM B-SPLINE KNOT POSITIONS.

LGRMAX - MAXIMUM NUMBER OF ITERATIONS IN LAGRANGIAN INTERPOLATIVE SEARCH FOR BEST POSITION OF A PARTICULAR KNOT WITH RESPECT TO WEIGHTED RMS.

EPS - KNOT ADJUSTMENT TOLERANCE WITHIN WHICH THE KNOT POSITION IS CONSIDERED TO HAVE CONVERGED.

KO - BOOLEAN NUMBER IN WHICH EACH DIGIT GOVERNS THE ADJUSTMENT OF A PARTICULAR INTERNAL KNOT POSITION, WITH LEFT-MOST DIGIT CORRESPONDING TO LEFT-MOST KNOT: (0) ADJUST (1) DO NOT ADJUST.

IOBS - INPUT UNIT CONTAINING B-SPLINE KNOT POSITIONS, FOURIER WAVEFORM FREQUENCIES, AND SIGMAS FOR OBSERVED MAGNETIC FIELD VALUES.

NAMELIST TRFORM -
===============

EU - FIT EULER ANGLES (DEGREES).

QI - GSFC NOMINAL BIAS CORRECTIONS IN ORIGINAL SATELLITE COORDINATES (NT).

QF - FIT MAGNETOMETER BIAS ADJUSTMENTS (NT).

CF - FIT CALIBRATION SLOPE ADJUSTMENT MATRIX.

CA - CALIBRATION MATRIX IN ORIGINAL SATELLITE COORDINATES.

RF - ROTATION MATRIX FROM ORIGINAL SATELLITE TO FIT/MAGSAT COORDINATES.

RC - ROTATION MATRIX FROM FIT/MAGSAT TO DESIRED SATELLITE COORDINATES.

NAMELIST CONTRL -
===============

IMODE - PROGRAM OPERATION MODE: (0) RAW-TO-FINAL FIT TAPE TOTAL PROCESSING (1) FILTER-TO-FINAL FIT TAPE PROCESSING (2) FILTER PROCESSING ONLY (3) RAW-TO-FILTER TAPE PROCESSING.

IFORM - ORIGINAL RAW DATA TAPE(S) FORMAT: (0) EARLY FORMAT -- 2 SAMPLES/SECOND (1) LATTER FORMAT -- 20 SAMPLES/SECOND

NDATAR - NUMBER OF DATA RECORDS PROCESSED AFTER EPHEMERIS RECORD.

INPUTF - NUMBER OF INPUT FILES TO BE PROCESSED.

IARC - ARC PROCESSING LENGTH: (0) ENTIRE ARC (1) ARC SEGMENT BETWEEN BEGINNING AND ENDING TIMES ONLY.

IYRBEG - BEGINNING ARC TIME YEAR SINCE 1900.

IDYBEG - BEGINNING ARC TIME DAY NUMBER.

ISCBEG - BEGINNING ARC TIME SECONDS.

IYREND - ENDING ARC TIME YEAR SINCE 1900.

IDYEND - ENDING ARC TIME DAY NUMBER.

ISCEND - ENDING ARC TIME SECONDS.

ORBINC - SATELLITE ORBIT INCLINATION ANGLE (DEGREES).

ERAD - MEAN EARTH RADIUS (KM).

IEPDAY - FILTER REFERENCE DAY NUMBER.

INCREM - FILTER WINDOW LENGTH (SECONDS).

INTRVL - FILTER WINDOW NUMBER FROM BEGINNING OF REFERENCE DAY.

IMETH - FILTER METHOD: (0) DETREND (1) DETREND AND FLAG OUTLIERS (2) FLAG OUTLIERS (3) NO MODIFICATION.

ISPEC - FFT SPECTRAL ANALYSIS: (0) NO ANALYSIS (1) ZERO-MEAN ANALYSIS (2) DIRECT ANALYSIS.

NEXTIN - NUMBER OF SUCCESSIVE FILTER WINDOWS TO BE PROCESSED DURING THIS RUN BEGINNING WITH WINDOW NUMBER "INTRVL".

IBTBS - FINAL TAPE OUTPUT COORDINATES: (0) FORMATTED TOPOCENTRIC (1) FORMATTED/BINARY FIT/MAGSAT (2) SAME AS 1, PLUS FORMATTED DESIRED SATELLITE.

SIGMLT - OUTLIER MULTIPLICATION FACTOR FOR TREND RESIDUAL SIGMA.

NFLAGK - DATA QUALITY FLAG RETENTION CODE FOR FILTER: EACH DIGIT INDICATES FLAG TO BE RETAINED FOR TREND FITTING.

IOWIOF - UNIT IOW INTERVALS FOR FINAL PROCESSING: (0) INTRVL ONLY (1) INTRVL AND PRECEEDING (2) ALL.

IOF1ST - OUTPUT DATA FLAG FOR UNITS IOF AND IOB: (0) DATA WILL BE APPENDED (1) DATA WILL BE FIRST.

IOD1ST - OUTPUT DATA FLAG FOR UNIT IOD: (0) DATA WILL BE APPENDED (1) DATA WILL BE FIRST.

IOW1ST - OUTPUT DATA FLAG FOR UNIT IOW: (0) DATA WILL BE APPENDED (1) DATA WILL BE FIRST.

NAMELIST OUTLIM -
===============

DXOL - MAGNITUDE TOLERANCE FOR RESIDUAL TOPOCENTRIC X COMPONENT (NT).

DYOL - MAGNITUDE TOLERANCE FOR RESIDUAL TOPOCENTRIC Y COMPONENT (NT).

DZOL - MAGNITUDE TOLERANCE FOR RESIDUAL TOPOCENTRIC Z COMPONENT (NT).

DBOL - MAGNITUDE TOLERANCE FOR RESIDUAL TOPOCENTRIC B COMPONENT (NT).

XWINDO - MAGNETIC LATITUDE TOLERANCE FOR FIT/MAGSAT X COMPONENT.

YWINDO - MAGNETIC LATITUDE TOLERANCE FOR FIT/MAGSAT Y COMPONENT.

ZWINDO - MAGNETIC LATITUDE TOLERANCE FOR FIT/MAGSAT Z COMPONENT.

BWINDO - MAGNETIC LATITUDE TOLERANCE FOR FIT/MAGSAT B COMPONENT.

ABVLAT - FILTER GEOCENTRIC LATITUDE TOLERANCE FOR ALL COMPONENTS.

TRNLAT - GEODETIC LATITUDE ABOVE WHICH SATELLITE VELOCITY DIRECTION IS INDETERMINABLE.

ITMGAP - TIME-GAP TOLERANCE INCREMENT FOR DATA (SECONDS).

...... RUN DECK FOR STAGE 1 ....

```
//XRJRRST1 JOB (F8002,X22,80),STEP1,TIME=(5,00),CLASS=A,MSGCLASS=X
/*JOBPARM LINES=100
//GO EXEC PGM=LOAD1,REGION=3000K
//STEPLIB DD DISP=SHR,DSN=XRJRR.SATFILT
//*
//* UNIT FOR INPUT PARAMETERS FOR PROGRAM FILTER FOLLOWS
//*
//GO.FT05F001 DD *
 DMSP MAR 19-21, 1984. STEP1 WITHOUT COORDINATE SWITCH! - RF=I MATRIX!
 &CONTRL IMODE=0, IFORM=1, IARC=0, ORBINC=98.74, IEPDAY=79,
         INCREM=21600, INTRVL=1, IMETH=2, ISPEC=1, NEXTIN=12,
         IOF1ST=1, INPUTF=1, &END
 &IOFILE IOR=13, IOW=14, &END
 &BSPLIN H(1)=17, H(2)=17, H(3)=17, NT(1)=0, NT(2)=0, NT(3)=0,
         NN(1)=4, NN(2)=4, NN(3)=4, &END
 &OUTLIM , &END
 &FIELDP , &END
 &TRFORM RF(1,1)=0.0, RF(1,2)=0.0, RF(1,3)=1.0,
         RF(2,1)=1.0, RF(2,2)=0.0, RF(2,3)=0.0,
         RF(3,1)=0.0, RF(3,2)=1.0, RF(3,3)=0.0,
         CA(1,1)=12.1001, CA(1,2)=-0.0055, CA(1,3)= 0.0193,
         CA(2,1)=-0.0247, CA(2,2)=12.1863, CA(2,3)=-0.0101,
         CA(3,1)= 0.0069, CA(3,2)= 0.0232, CA(3,3)=12.1735,
         QI(1)=89.0, QI(2)=8457.0, QI(3)=-1441.0,
         EU(1)=0.00, EU(2)=0.00, EU(3)=0.00, &END
//*
//* PRINTER OUTPUT UNIT FOLLOWS
//*
//GO.FT06F001 DD SYSOUT=*,SPACE=(CYL,(20,9),RLSE)
//*
//* PLOT TAPE UNIT FOLLOWS  (RARELY USED, SO DUMMY OUT)
//*
//*GO.FT08F001 DD UNIT=(1600,,DEFER),LABEL=(1,NL,,OUT),
//*DCB=(RECFM=VBS,LRECL=364,BLKSIZE=368,DEN=3),VOL=SER=JRR001
//GO.FT08F001 DD DUMMY
//*
//* NEW-FORMAT SATELLITE MAGNETIC TAPE UNIT FOLLOWS
//*
//GO.FT10F001 DD DISP=(OLD,KEEP),UNIT=6250,LABEL=(1,NL,,IN),
// DCB=(RECFM=FB,LRECL=75,BLKSIZE=1875,DEN=4,OPTCD=Q),VOL=SER=DT0031
//*
//* PERMANENT RE-USABLE DATA SETS FOLLOW (LEAVE AS IS ON STEP1)
//*
//GO.FT11F001 DD DSN=XRTJS.DMSP.STEP2.DATA,DISP=SHR
//*DCB=(RECFM=FB,LRECL=240,BLKSIZE=4800),UNIT=SYSDA,
//*SPACE=(TRK,(20,10),RLSE),VOL=SER=SACC09
//GO.FT12F001 DD DSN=XRTJS.DMSP.STEP3.DATA,DISP=SHR
//*DCB=(RECFM=FB,LRECL=240,BLKSIZE=4800),UNIT=SYSDA,
//*SPACE=(TRK,(20,10),RLSE),VOL=SER=SACC05
//*O.FT13F001 DD DSN=XRJRR.DMSP.STEP1S.JAN17.DATA,DISP=SHR
//GO.FT13F001 DD DSN=XRTJS.DMSP.STEP4.DATA,DISP=SHR
```

```
//GO.FT14F001 DD DSN=XRTJS.DMSP.STEP5.DATA,DISP=SHR
//*
//*
//* RUN-SPECIFIC OUTPUT DATA SETS FOLLOW
//*
//GO.FT15F001 DD DUMMY,DSN=XRSHS.SEP1684.STEP1.OUTF,DISP=(NEW,CATLG),
//  DCB=(RECFM=FB,LRECL=240,BLKSIZE=4800),UNIT=SYSDA,
//  SPACE=(TRK,(20,10),RLSE),VOL=SER=SACC02
//GO.FT17F001 DD DSN=XRJRR.EUTEST.MAR1984.STEP1,DISP=SHR
//*DCB=(RECFM=VBS,LRECL=11204,BLKSIZE=22412),UNIT=SYSDA,
//*SPACE=(TRK,(20,10),RLSE),VOL=SER=SACC06
//*
//* SCRATCH DATA SETS FOLLOW
//* (BINARY, WILL NEVER LOOK AT)
//GO.FT18F001 DD UNIT=SYSDA,DISP=(,PASS),SPACE=(TRK,(2,1),RLSE),
// DCB=(RECFM=FB,LRECL=80,BLKSIZE=7200)
//GO.FT19F001 DD UNIT=SYSDA,DISP=(,PASS),SPACE=(TRK,(2,1),RLSE),
// DCB=(RECFM=FB,LRECL=80,BLKSIZE=7200)
//GO.FT20F001 DD UNIT=SYSDA,DISP=(,PASS),SPACE=(TRK,(2,1),RLSE),
// DCB=(RECFM=FB,LRECL=80,BLKSIZE=7200)
//*
//* INPUT MAGNETIC FIELD DATA SET FOLLOWS
//* (KEEP AS IS FOR STEP1)
//GO.FT21F001 DD DSN=XRJRR.DATA.MISC(CAL84FID),DISP=SHR
//*
//* INPUT TREND-FIT DATA SET FOLLOWS
//*
//GO.FT22F001 DD DSN=XRTJS.BSPINFO.DATA,DISP=SHR
//*
//* SYSTEM DUMP FOR ABEND-AID FOLLOWS
//*
//GO.SYSUDUMP DD DUMMY
// EXEC NOTIFYTS
```

```
...... RUN DECK FOR STAGE 4 .......
//XRJRRST4 JOB (F8002,X22,80),STEP4,TIME=(10,00),CLASS=F,MSGCLASS=X
/*JOBPARM LINES=100
//GO EXEC PGM=LOAD1,REGION=3000K
//STEPLIB DD DISP=SHR,DSN=XRJRR.SATFILT
//*
//* UNIT FOR INPUT PARAMETERS FOR PROGRAM FILTER FOLLOWS
//*
//GO.FT05F001 DD *
 DMSP SEP 16,18 1984. INPUT FIELD FROM FIT.  STEP4.
 &CONTRL IMODE=0, IFORM=1, IARC=0, ORBINC=98.74, IEPDAY=260,
         INCREM=21600, INTRVL=1, IMETH=2, ISPEC=1, NEXTIN=12,
         IOF1ST=1, INPUTF=1, &END
 &IOFILE IOR=13, IOW=14, &END
 &BSPLIN H(1)=17, H(2)=17, H(3)=17, NT(1)=0, NT(2)=0, NT(3)=0,
         NN(1)=4, NN(2)=4, NN(3)=4, &END
 &OUTLIM , &END
 &FIELDP , &END
 &TRFORM RF(1,1)=0.0, RF(1,2)=0.0, RF(1,3)=1.0,
         RF(2,1)=1.0, RF(2,2)=0.0, RF(2,3)=0.0,
         RF(3,1)=0.0, RF(3,2)=1.0, RF(3,3)=0.0,
         CA(1,1)=12.1001, CA(1,2)=-0.0055, CA(1,3)= 0.0193,
         CA(2,1)=-0.0247, CA(2,2)=12.1863, CA(2,3)=-0.0101,
         CA(3,1)= 0.0069, CA(3,2)= 0.0232, CA(3,3)=12.1735,
         QI(1)=89.0, QI(2)=8457.0, QI(3)=-1441.0,
         EU(1)=-.47839 EU(2)=-.09246, EU(3)=-0.00609,
         QF(1)=-18.4,QF(2)=-9.46,QF(3)=-2.35, &END
//*
//* PRINTER OUTPUT UNIT FOLLOWS
//*
//GO.FT06F001 DD SYSOUT=*,SPACE=(CYL,(20,9),RLSE)
//*
//* PLOT TAPE UNIT FOLLOWS  (RARELY USED, SO DUMMY OUT)
//*
//*GO.FT08F001 DD UNIT=(1600,,DEFER),LABEL=(1,NL,,OUT),
//*DCB=(RECFM=VBS,LRECL=364,BLKSIZE=368,DEN=3),VOL=SER=JRR001
//GO.FT08F001 DD DUMMY
//*
//* NEW-FORMAT SATELLITE MAGNETIC TAPE UNIT FOLLOWS
//*
//GO.FT10F001 DD DISP=(OLD,KEEP),UNIT=6250,LABEL=(1,NL,,IN),
// DCB=(RECFM=FB,LRECL=75,BLKSIZE=1875,DEN=4,OPTCD=Q),VOL=SER=DT0108
//*
//* PERMANENT RE-USABLE DATA SETS FOLLOW (LEAVE AS IS ON STEP1)
//*
//GO.FT11F001 DD DSN=XRTJS.DMSP.STEP2.DATA,DISP=SHR
//*DCB=(RECFM=FB,LRECL=240,BLKSIZE=4800),UNIT=SYSDA,
//*SPACE=(TRK,(20,10),RLSE),VOL=SER=SACC09
//GO.FT12F001 DD DSN=XRTJS.DMSP.STEP3.DATA,DISP=SHR
//*DCB=(RECFM=FB,LRECL=240,BLKSIZE=4800),UNIT=SYSDA,
//*SPACE=(TRK,(20,10),RLSE),VOL=SER=SACC05
//*O.FT13F001 DD DSN=XRJRR.DMSP.STEP1S.JAN17.DATA,DISP=SHR
//GO.FT13F001 DD DSN=XRTJS.DMSP.STEP4.DATA,DISP=SHR
```

```
//GO.FT14F001 DD DSN=XRTJS.DMSP.STEP5.DATA,DISP=SHR
//*
//*
//* RUN-SPECIFIC OUTPUT DATA SETS FOLLOW
//*
//GO.FT15F001 DD DSN=XRSHS.SEP1684.STEP4.OUTF,DISP=(NEW,CATLG),
// DCB=(RECFM=FB,LRECL=240,BLKSIZE=4800),UNIT=SYSDA,
// SPACE=(TRK,(20,10),RLSE),VOL=SER=SACC04
//GO.FT17F001 DD DUMMY
//*
//* SCRATCH DATA SETS FOLLOW
//* (BINARY, WILL NEVER LOOK AT)
//GO.FT18F001 DD UNIT=SYSDA,DISP=(,PASS),SPACE=(TRK,(2,1),RLSE),
// DCB=(RECFM=FB,LRECL=80,BLKSIZE=7200)
//GO.FT19F001 DD UNIT=SYSDA,DISP=(,PASS),SPACE=(TRK,(2,1),RLSE),
// DCB=(RECFM=FB,LRECL=80,BLKSIZE=7200)
//GO.FT20F001 DD UNIT=SYSDA,DISP=(,PASS),SPACE=(TRK,(2,1),RLSE),
// DCB=(RECFM=FB,LRECL=80,BLKSIZE=7200)
//*
//* INPUT MAGNETIC FIELD DATA SET FOLLOWS
//* (PUT FILE FROM STEP3 HERE)
//GO.FT21F001 DD DSN=XRSHS.SEP1684.STEP3.COEFFS,DISP=SHR
//*
//* INPUT TREND-FIT DATA SET FOLLOWS
//*
//GO.FT22F001 DD DSN=XRTJS.BSPINFO.DATA,DISP=SHR
//*
//* SYSTEM DUMP FOR ABEND-AID FOLLOWS
//*
//GO.SYSUDUMP DD DUMMY
// EXEC NOTIFYTS
```

...... RUN DECK FOR STAGE 5 ....

```
//XRJRRST5 JOB (F8002,X22,50),STEP5,TIME=(10,00),CLASS=F,MSGCLASS=X
/*JOBPARM LINES=150
//GO EXEC PGM=LOAD1,REGION=3000K
//STEPLIB DD DISP=SHR,DSN=XRJRR.SATFILT
//*
//* UNIT FOR INPUT PARAMETERS FOR PROGRAM FILTER FOLLOWS
//*
//GO.FT05F001 DD *
 MAY 6-8,1984. STEP5. FOURIER REMOVAL STEP, USING NEW FIELD MODEL.
 &CONTRL IMODE=1,IFORM=1,IARC=0, ORBINC=98.74, IEPDAY=127,INCREM=21600,
         INTRVL=1, IMETH=1, ISPEC=1, NEXTIN=12,SIGMLT=2.8,
         IOF1ST=1, INPUTF=1, &END
 &IOFILE IOR=13, IOW=14, &END
 &BSPLIN H(1)=17, H(2)=17, H(3)=17, NT(1)=4, NT(2)=4, NT(3)=4,
         NN(1)=0, NN(2)=0, NN(3)=0, &END
 &OUTLIM , &END
 &FIELDP , &END
 &TRFORM RF(1,1)=0.0, RF(1,2)=0.0, RF(1,3)=1.0,
         RF(2,1)=1.0, RF(2,2)=0.0, RF(2,3)=0.0,
         RF(3,1)=0.0, RF(3,2)=1.0, RF(3,3)=0.0,
         CA(1,1)=12.1001, CA(1,2)=-0.0055, CA(1,3)= 0.0193,
         CA(2,1)=-0.0247, CA(2,2)=12.1863, CA(2,3)=-0.0101,
         CA(3,1)= 0.0069, CA(3,2)= 0.0232, CA(3,3)=12.1735,
         QI(1)=89.0, QI(2)=8457.0, QI(3)=-1441.0,
         EU(1)=0.000, EU(2)=0.000, EU(3)=0.000, &END
//*
//* PRINTER OUTPUT UNIT FOLLOWS
//*
//GO.FT06F001 DD SYSOUT=*,SPACE=(CYL,(20,9),RLSE)
//*
//* PLOT TAPE UNIT FOLLOWS
//*
//*GO.FT08F001 DD UNIT=(1600,,DEFER),LABEL=(1,NL,,OUT),
//*DCB=(RECFM=VBS,LRECL=364,BLKSIZE=368,DEN=3),VOL=SER=JRR001
//GO.FT08F001 DD DUMMY
//*
//* DO NOT USE UNIT#10 FOR THIS STEP.
//GO.FT10F001 DD DUMMY
//*
//* PERMANENT RE-USABLE DATA SETS FOLLOW
//*
//GO.FT11F001 DD DSN=XRTJS.DMSP.STEP2.DATA,DISP=SHR
//*DCB=(RECFM=FB,LRECL=240,BLKSIZE=4800),UNIT=SYSDA,
//*SPACE=(TRK,(20,10),RLSE),VOL=SER=SACC09
//GO.FT12F001 DD DSN=XRTJS.DMSP.STEP3.DATA,DISP=SHR
//*DCB=(RECFM=FB,LRECL=240,BLKSIZE=4800),UNIT=SYSDA,
//*SPACE=(TRK,(20,10),RLSE),VOL=SER=SACC05
//*
```

```
//*** INPUT ON UNIT #13, WHICH IS THE OUTPUT FROM STEP4 (FORMATTED).
//GO.FT13F001 DD DSN=XRSHS.MAY684.STEP4.OUTF,DISP=SHR
//*
//GO.FT14F001 DD DSN=XRTJS.DMSP.STEP5.DATA,DISP=SHR
//*DCB=(RECFM=FB,LRECL=240,BLKSIZE=4800),UNIT=SYSDA,
//*SPACE=(TRK,(20,10),RLSE),VOL=SER=SACC08
//*
//*
//* RUN-SPECIFIC OUTPUT DATA SETS FOLLOW
//* (OUTPUT BOTH FORMATTED AND BINARY DATA SETS).
//GO.FT15F001 DD DSN=XRSHS.MAY684.STEP5.OUTF,DISP=(NEW,CATLG),
//  VOL=SER=SACC04,SPACE=(TRK,(20,10),RLSE),UNIT=SYSDA,
//  DCB=(RECFM=FB,LRECL=240,BLKSIZE=4800)
//GO.FT17F001 DD DSN=XRSHS.MAY684.STEP5.OUTBIN,DISP=(NEW,CATLG),
//  VOL=SER=SACC04,SPACE=(TRK,(20,10),RLSE),UNIT=SYSDA,
//  DCB=(RECFM=VBS,LRECL=11204,BLKSIZE=22412)
//*
//* SCRATCH DATA SETS FOLLOW
//* (BINARY, WILL NEVER LOOK AT)
//GO.FT18F001 DD UNIT=SYSDA,DISP=(,PASS),SPACE=(TRK,(2,1),RLSE),
// DCB=(RECFM=FB,LRECL=80,BLKSIZE=7200)
//GO.FT19F001 DD UNIT=SYSDA,DISP=(,PASS),SPACE=(TRK,(2,1),RLSE),
// DCB=(RECFM=FB,LRECL=80,BLKSIZE=7200)
//GO.FT20F001 DD UNIT=SYSDA,DISP=(,PASS),SPACE=(TRK,(2,1),RLSE),
// DCB=(RECFM=FB,LRECL=80,BLKSIZE=7200)
//*
//* INPUT MAGNETIC FIELD DATA SET FOLLOWS
//* ( THIS IS THE FIELD OUTPUT FROM STEP3 )
//GO.FT21F001 DD DSN=XRSHS.MAY684.STEP3.COEFFS,DISP=SHR
//*
//* INPUT TREND-FIT DATA SET FOLLOWS
//*
//GO.FT22F001 DD DSN=XRTJS.BSPINFO.DATA,DISP=SHR
//*
//* SYSTEM DUMP FOR ABEND-AID FOLLOWS
//*
//GO.SYSUDUMP DD DUMMY
// EXEC NOTIFYTS
```

B. For STAGE 2 there are two deck setups, one using the load module and one using the source code.

Note that for Unit 10 the tape is a dummy. The additional "information" is irrelevant to this run, but might be useful in other applications. These setups include an input set of SHA coefficients as a starting model for FIT and a list of observatories and their biases as determined in an earlier FIT. The basic program is the old FIT program.

..... STAGE 2 Run Deck with load module .....

```
//XRJRRTS2 JOB (G0111,X22,20),EUTST,TIME=(7,00),NOTIFY=XRJRR,CLASS=0,
//  MSGCLASS=X
/*JOBPARM LINES=15
//*
//*XRJRR.DTAPE.PROCESS(STEP2) -- USE OF A LOAD MODULE (FIT.DMSP.LOAD2)
//*  INPUT TO THIS STEP IS FILE "OUTBIN" ON UNIT#17, FROM STEP1.
//*  INPUT IS ON UNIT #19.
//*  THE JOB SETUP PARAMETERS ARE ON UNIT #5.
//GO EXEC PGM=FIT,REGION=3000K
//STEPLIB DD DISP=SHR,DSN=XRJRR.FIT.DMSP.LOAD2
//GO.FT01F001 DD UNIT=SYSDA,SPACE=(CYL,(7,2),RLSE),
//   DCB=(RECFM=VBST,LRECL=200,BLKSIZE=12004)
//GO.FT02F001 DD UNIT=SYSDA,SPACE=(CYL,(7,2),RLSE),
//   DCB=(RECFM=VBST,LRECL=200,BLKSIZE=12004)
//GO.FT06F001 DD SYSOUT=*
//GO.FT07F001 DD DUMMY,SYSOUT=B,DCB=(RECFM=FB,LRECL=80,BLKSIZE=7280),
//   SPACE=(CYL,(0,1),RLSE)
//GO.FT10F001 DD DUMMY,DSN=POG6CQ,UNIT=(9TRACK,,DEFER),DISP=(OLD,KEEP),
// DCB=(RECFM=VBS,LRECL=4004,BLKSIZE=4008),LABEL=(1,SL,,IN),
// VOL=SER=MAG001
//GO.FT10F002 DD DUMMY,DSN=POG6MQ,UNIT=(9TRACK,,DEFER),DISP=(OLD,KEEP),
// DCB=(RECFM=VBS,LRECL=4004,BLKSIZE=4008),LABEL=(2,SL,,IN),
// VOL=SER=MAG001
//GO.FT10F003 DD DUMMY,DSN=POG246,UNIT=(9TRACK,,DEFER),DISP=(OLD,KEEP),
// DCB=(RECFM=VBS,LRECL=4004,BLKSIZE=4008),LABEL=(3,SL,,IN),
// VOL=SER=MAG001
//*
//*  UNIT 11 IS A NORMAL MATRIX FILE.  THIS IS NEEDED IN STEP 2
//*  ONLY IF STATISTICS ON THE INPUT DATA ARE DESIRED.
//FT11F001 DD DSN='XRJRR.FIT.OUT.NMATX',DISP=SHR
//*
//*  UNIT 12 IS A SCRATCH FILE.
//FT12F001 DD UNIT=SYSDA,DISP=(,PASS),SPACE=(TRK,(90,20),RLSE),
//      DCB=(RECFM=VBS,LRECL=100,BLKSIZE=7204)
//GO.FT13F001 DD DUMMY
//FT15F001 DD DUMMY
//FT16F001 DD DUMMY
//FT17F001 DD DUMMY
//FT18F001 DD DUMMY
//*
//* BINARY INPUT DATA FOLLOWS.   MUST BE IN FIT BINARY FORMAT.
//*T19F001 DD DSN=XRJRR.EUTEST.MAR1984.STEP1,DISP=SHR
//FT19F001 DD DSN=XRJRR.MAR1984.STEP1.OUTBIN,DISP=SHR
//*
//FT22F001 DD UNIT=SYSDA,DISP=(,PASS),SPACE=(TRK,(40,10),RLSE),
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=7200)
//FT23F001 DD UNIT=SYSDA,DISP=(,PASS),SPACE=(TRK,(40,10),RLSE),
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=7200)
//FT24F001 DD UNIT=SYSDA,DISP=(,PASS),SPACE=(TRK,(40,10),RLSE),
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=7200)
//*
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//*  OUTPUT COEFFICIENTS FOLLOW.
//FT25F001 DD DSN=XRJRR.FIT.DMSP.COEFFS,UNIT=SYSDA,DISP=SHR
//*VOL=SER=SACC09,DCB=(RECFM=FB,LRECL=80,BLKSIZE=8000),
//*SPACE=(TRK,(2,2),RLSE),DISP=(NEW,CATLG)
//*
//FT35F001 DD DUMMY
//FT36F001 DD DUMMY
//FT40F001 DD DUMMY
//FT45F001 DD DUMMY
//SYSUDUMP DD DUMMY
//FT05F001 DD *
 &CONTRL      NSIML=0, IRSTRT=0,NOISE=0,RTIM=9999.,
 EULER=2,IBIAS=1,
      ITER=2,
 NSKIP=1,
 &END
 MARCH 19-21, 1984, TEST OF DMSP EULER ANGLE SOLUTION.
 &FIELD    MONO=2,
  NMAXR=0,    NMAXTR=0,
 BGNTIM=0.,
 EXTFLD=0,NEXT=0
 PRCORL=4,
 IDST=0,
 EPOCH=1984.22,AVETIM=1984.22,
 NMAX=11,NMAXT=9,NMAXTT=0,NMXTTT=0,NMAXIV=0,NMAXV=0,
 &END
 &LIMERR ERRLIM=2*20.,8*1000.,                    3*1000.,2*.0012,2*30.,
 NTDATA=1,NAT(1)=8,NAT(2)=2,APRIOR=0,
 NSTOP=0,
 AYSTAT=1,   BIASAP=5000.,
    NDGEN=5,   &END
  2  1-29878.2     0.000000E+00 26.9879     0.000000E+000.000000E+000.000000E+00
  2  2-1924.05      5526.55      7.95582    -19.3154      0.000000E+000.000000E+00
  3  1-2063.34     0.000000E+00-16.6929     0.000000E+000.000000E+000.000000E+00
  3  2 3044.32     -2183.87      4.24784    -13.6396      0.000000E+000.000000E+00
  3  3 1682.87     -291.646      5.04403    -22.9796      0.000000E+000.000000E+00
  4  1 1279.34     0.000000E+00-.558737     0.000000E+000.000000E+000.000000E+00
  4  2-2200.81     -317.451     -5.07226     4.55282      0.000000E+000.000000E+00
  4  3 1250.13      282.905     -.185285     3.00112      0.000000E+000.000000E+00
  4  4 831.335     -289.166     -.373123    -9.23767      0.000000E+000.000000E+00
  5  1 943.053     0.000000E+00 1.34613     0.000000E+000.000000E+000.000000E+00
  5  2 776.331      230.858     -1.48226     4.66531      0.000000E+000.000000E+00
  5  3 370.782     -248.342     -6.77951     2.08782      0.000000E+000.000000E+00
  5  4-424.398      64.1152     -1.36512     2.80991      0.000000E+000.000000E+00
  5  5 174.567     -294.299     -6.07800    0.717217      0.000000E+000.000000E+00
  6  1-211.934     0.000000E+00 1.48473     0.000000E+000.000000E+000.000000E+00
  6  2 358.879      45.6865     0.409051    -.126245      0.000000E+000.000000E+00
  6  3 252.241      145.820     -2.20934    -.996403      0.000000E+000.000000E+00
  6  4-90.4987     -152.384     -4.06068    -.441015      0.000000E+000.000000E+00
  6  5-162.388     -77.5140     -.119331    0.529454E-010.000000E+000.000000E+00
  6  6-48.5517      97.0991     -.127636     1.24753      0.000000E+000.000000E+00
  7  1 50.2750     0.000000E+000.582770     0.000000E+000.000000E+000.000000E+00
  7  2 65.8066     -14.4218     0.735771E-010.834850E-010.000000E+000.000000E+00
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  7  3 48.4155     88.5492     1.62415     -1.12290     0.000000E+000.000000E+00
  7  4-186.477     71.0999     1.40833     0.130572     0.000000E+000.000000E+00
  7  5 1.98577    -47.6321    -.400328     -1.14035     0.000000E+000.000000E+00
  7  6 15.7450    -2.92768    0.481683     -.177513     0.000000E+000.000000E+00
  7  7-103.694     20.6672     1.00832     0.861644     0.000000E+000.000000E+00
  8  1 75.1637    0.000000E+000.801818     0.000000E+000.000000E+000.000000E+00
  8  2-62.4921    -83.4985    -.823360     -.239219     0.000000E+000.000000E+00
  8  3 2.80617    -24.7745    0.344860     0.661025     0.000000E+000.000000E+00
  8  4 23.7248    -4.34651    0.746856     0.200311     0.000000E+000.000000E+00
  8  5-4.97948     20.8105     1.86428      1.13190     0.000000E+000.000000E+00
  8  6 1.19654     21.6843    0.140686     0.974664     0.000000E+000.000000E+00
  8  7 10.5049    -23.1920    -.207177E-01-.463253E-010.000000E+000.000000E+00
  8  8-2.16799    -5.21783    -.121684      1.11800     0.000000E+000.000000E+00
  9  1 20.3340    0.000000E+000.462131     0.000000E+000.000000E+000.000000E+00
  9  2 5.24161     6.06898    -.324161     -.183895     0.000000E+000.000000E+00
  9  3 1.01194    -18.4504    0.363677     -.236736     0.000000E+000.000000E+00
  9  4-9.58137     6.24225    0.352333     0.509160     0.000000E+000.000000E+00
  9  5-10.2597    -23.2842    -.831963     -.270271     0.000000E+000.000000E+00
  9  6 3.37727     6.95803    -.212720     -.542091     0.000000E+000.000000E+00
  9  7 3.81301     14.4615    0.274855     -.405454     0.000000E+000.000000E+00
  9  8 4.60530    -15.2854    -.353735     -.520160     0.000000E+000.000000E+00
  9  9-2.70855    -11.8510    -.332573     0.677450     0.000000E+000.000000E+00
 10  1 5.44687    0.000000E+000.000000E+000.000000E+000.000000E+000.000000E+00
 10  2 10.3427    -20.8446    0.000000E+000.000000E+000.000000E+000.000000E+00
 10  3 1.53718     15.3630    0.000000E+000.000000E+000.000000E+000.000000E+00
 10  4-12.3475     8.96920    0.000000E+000.000000E+000.000000E+000.000000E+00
 10  5 9.43396    -5.32006    0.000000E+000.000000E+000.000000E+000.000000E+00
 10  6-3.42227    -6.34494    0.000000E+000.000000E+000.000000E+000.000000E+00
 10  7-1.19068     8.99323    0.000000E+000.000000E+000.000000E+000.000000E+00
 10  8 6.68696     9.64659    0.000000E+000.000000E+000.000000E+000.000000E+00
 10  9 1.51691    -5.95444    0.000000E+000.000000E+000.000000E+000.000000E+00
 10 10-5.00116     1.95644    0.000000E+000.000000E+000.000000E+000.000000E+00
 11  1-3.43391    0.000000E+000.000000E+000.000000E+000.000000E+000.000000E+00
 11  2-3.99290     1.28190    0.000000E+000.000000E+000.000000E+000.000000E+00
 11  3 2.22121    0.472492    0.000000E+000.000000E+000.000000E+000.000000E+00
 11  4-5.42399     2.66175    0.000000E+000.000000E+000.000000E+000.000000E+00
 11  5-1.98615     5.76969    0.000000E+000.000000E+000.000000E+000.000000E+00
 11  6 4.57595    -4.23475    0.000000E+000.000000E+000.000000E+000.000000E+00
 11  7 3.15891    -.422710    0.000000E+000.000000E+000.000000E+000.000000E+00
 11  80.908603    -1.35638    0.000000E+000.000000E+000.000000E+000.000000E+00
 11  9 1.98001     3.56776    0.000000E+000.000000E+000.000000E+000.000000E+00
 11 10 2.79926    -.462133    0.000000E+000.000000E+000.000000E+000.000000E+00
 11 11-.274364    -6.13455    0.000000E+000.000000E+000.000000E+000.000000E+00
  0  0
  0
 &EUORBS Y1=0.D0,Z1=0.D0,Z2=0.D0,
 EUD(1,1)=0.D0,EUD(2,1)=0.D0,EUD(3,1)=0.D0,
 EUD(1,2)=0.D0,EUD(2,2)=0.D0,EUD(3,2)=0.D0,
 BS1=0.D0,BS2=0.D0,BS3=0.D0,
 BST1=0.D0,BST2=0.D0,BST3=0.D0,
 &END
  0
```

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&TAPENO ITAPE=1,IFILE=1,IMODE=1,ISELEC=0,DLATLM=75.D0,
TIM1=1979.,TIM2=1999.,VECLIM=90.,THETA0=11.12,PHI0=289.2, &END
1   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.
         1
6
0
  1960.0    1999.0
```

ABINGER	0.80	0.44	0.16
ABISKO	1.22	1.37	2.06
ADAK	5.92	2.05	8.17
ADDIS ABABA	3.26	5.11	3.15
AGINCOURT	2.52	2.08	5.08
ALERT	5.24	8.18	19.86
ALIBAG	7.16	2.47	6.23
ALIBAG II	1.17	0.96	1.18
ALMA ATA	3.16	3.05	2.76
ALMERIA	3.37	1.48	2.91
AMBERLEY II	2.60	0.96	2.90
ANCHORAGE	9999.00	9999.00	9999.00
ANNAMALAINAGAR	7.13	7.74	10.89
APIA III	3.53	1.66	2:27
AQUILA	2.42	1.23	1.92
ARGENTINE ISLND	3.98	1.39	2.61
ARTI	2.63	1.12	3.36
ASO	9999.00	9999.00	9999.00
AVERROES	9999.00	9999.00	9999.00
BAKER LAKE	3.13	3.28	4.44
BANGUI	10.96	4.67	4.06
BANGUI II	0.47	4.88	1.82
BANGUI III	6.46	5.64	3.32
BARROW II	5.03	3.04	27.69
BARROW III	3.06	2.81	6.57
BARTER ISLAND	9999.00	9999.00	9999.00
BEIJING	4.25	1.86	3.35
BELOIT	9999.00	9999.00	9999.00
BELSK	2.14	1.73	1.93
BEREZNAYKI	2.34	5.63	4.87
BIG DELTA	9999.00	9999.00	9999.00
BINZA	6.19	4.99	2.95
BJORNOYA	2.01	3.52	4.16
BOULDER	2.53	1.45	1.93
BUDAKESZI	9999.00	9999.00	9999.00
BUDKOV	1.92	0.88	1.67
BURLINGTON	9999.00	9999.00	9999.00
BYRD II	4.00	1.95	7.55
CAMBRIDGE BAY	3.18	2.05	2.89
CANBERRA	0.62	2.85	1.64
CARROLLTON	9999.00	9999.00	9999.00
CASEY	48.80	0.82	53.70
CASPER	9999.00	9999.00	9999.00
CASTELLACCIO	1.93	0.64	6.00
CASTLE ROCK	5.87	4.57	4.37
CHA PA	5.96	3.54	7.86

CHAMBON FORET	2.96	1.38	4.96
CHANGCHUN	9999.00	9999.00	9999.00
CHELTENHAM	9999.00	9999.00	9999.00
CHELYUSKIN II	2.23	2.03	7.54
COIMBRA	2.91	1.35	2.26
COLLEGE	2.89	1.59	3.87
COSTA RICA	9999.00	9999.00	9999.00
DALLAS	2.45	1.03	1.95
DAVIS	9999.00	9999.00	9999.00
DIKSON II	4.30	2.79	9.86
DOMBAS II	2.57	1.53	1.84
DOURBES	1.81	1.11	2.27
DRUZHNAYA	5.40	5.56	15.94
DUMONT DURVILLE	4.85	4.75	14.95
DUSHETI	4.23	1.92	4.69
DYMER	1.76	1.08	2.05
EBRO	3.16	1.49	1.99
EIGHTS	4.19	0.42	4.33
ELISABETHVILLE	2.31	1.15	3.06
ESKDALEMUIR	1.96	1.23	2.60
ESPANOLA	9999.00	9999.00	9999.00
EYREWELL	9999.00	9999.00	9999.00
FANNING ISLAND	9999.00	9999.00	9999.00
FORT CHURCHILL	3.67	2.72	3.93
FORT YUKON	9999.00	9999.00	9999.00
FREDERICKSBURG	3.21	1.08	2.90
FUQUENE	2.46	2.25	7.60
FURSTNFELDBRUCK	2.39	0.96	2.09
GIBILMANNA	9999.00	9999.00	9999.00
GNANGARA	2.05	1.01	2.07
GODHAVN	1.86	1.49	4.21
GONZALEZ VIDELA	9999.00	9999.00	9999.00
GORNOTAYEZHNAYA	3.21	1.25	5.64
GREAT WHALE R	6.43	2.01	4.20
GROCKA	2.27	0.83	2.40
GUAM	3.65	1.24	2.16
GUANGZHOU	9999.00	9999.00	9999.00
HALLETT STATION	11.86	20.93	109.30
HALLEY BAY	9.35	27.52	31.37
HARTEBEESTHOEK	9999.00	9999.00	9999.00
HARTLAND	1.95	0.93	1.95
HATIZYO	9999.00	9999.00	9999.00
HAVANA	2.23	1.57	4.43
HEALY	9999.00	9999.00	9999.00
HEL	2.00	1.61	2.28
HELWAN	0.45	2.41	2.19
HERMANUS	2.90	1.24	1.32
HOLLANDIA	5.51	2.49	7.33
HONGKONG	25.75	9.58	8.04
HONOLULU IV	3.40	0.82	1.46
HUANCAYO	3.61	1.54	2.20
HURBANOVO	2.89	1.06	2.98
HYDERABAD	3.98	14.84	2.58

IBADAN	3.68	6.56	1.92
ISLA DE PASCUA	9999.00	9999.00	9999.00
ISTANBL KNDILLI	2.07	1.47	4.34
JAIPUR	9.67	0.61	23.81
JARVIS ISLAND	9999.00	9999.00	9999.00
JASSY	9999.00	9999.00	9999.00
JULIANEHAAB II	15.00	15.00	15.00
KAKIOKA	3.46	1.47	3.42
KANOYA	3.44	0.78	1.20
KANOZAN	3.94	1.34	2.36
KELES	3.07	0.71	4.35
KERGUELEN	3.36	2.81	2.65
KIEV	6.72	3.56	2.44
KLYUCHI	3.22	0.83	2.74
KODAIKANAL	5.09	5.08	4.30
KOROR	15.00	15.00	15.00
KOTZEBUE	9999.00	9999.00	9999.00
KRASNAYA PAKHRA	1.84	1.33	2.84
KSARA	6.68	1.83	19.61
L AMERICA III	9999.00	9999.00	9999.00
L AMERICA V	9999.00	9999.00	9999.00
LA PAZ	3.80	1.77	12.02
LA QUIACA II	4.87	1.69	2.39
LANZHOU	9999.00	9999.00	9999.00
LAUDER	9999.00	9999.00	9999.00
LAZAREVA	9999.00	9999.00	9999.00
LEADVILLE	9999.00	9999.00	9999.00
LEIRVOGUR	2.82	1.43	3.73
LERWICK	1.79	1.38	2.05
LHASA	5.53	2.18	4.19
LOGRONO	2.64	2.48	2.01
LOPARSKOYE	2.37	2.19	5.10
LOVO	1.93	1.03	2.10
LUANDA BELAS	6.44	2.74	10.29
LUNPING	3.37	1.85	2.44
LVOV	3.07	1.02	4.37
LWIRO	6.12	1.79	2.14
M BOUR	3.17	4.87	1.91
MACQUARIE ISLND	3.03	5.87	4.65
MAGADAN	1.63	1.08	30.43
MAJURO	0.89	7.10	1.10
MANHAY	3.54	4.62	6.27
MAPUTO	4.15	3.33	4.11
MARION ISLAND	5.96	0.99	1.91
MARTIN VIVIES	9999.00	9999.00	9999.00
MAURITIUS II	8.38	4.52	13.17
MAWSON	3.30	4.36	7.49
MEANOOK	3.74	2.30	6.57
MEMAMBETSU	3.46	0.76	2.81
MIDWAY	9999.00	9999.00	9999.00
MIRNYY	5.10	4.38	11.53
MISALLAT	3.68	2.24	3.91
MOCA	3.22	2.65	1.68

MODIIM	9999.00	9999.00	9999.00
MOLODEZHNAYA	7.51	7.79	22.67
MONTE CAPELLINO	6.27	6.29	7.48
MOULD BAY	2.35	2.61	3.66
MUNTINLUPA	4.33	3.51	3.78
NAGYCENK	3.65	2.38	3.53
NAIROBI	3.77	2.88	6.36
NANTES	3.25	1.77	4.59
NEWPORT	2.16	1.17	2.08
NIEMEGK	2.18	0.99	2.25
NITZANIM	9999.00	9999.00	9999.00
NORTHWAY	9999.00	9999.00	9999.00
NORWAY STATION	9999.00	9999.00	9999.00
NOVO KAZALINSK	6.13	21.64	5.21
NOVOLAZAREVSKAY	3.49	4.57	16.75
NURMIJARVI	2.71	1.53	2.52
OASIS	9999.00	9999.00	9999.00
ORCADAS DEL SUR	9999.00	9999.00	9999.00
PAMATAI	5.17	1.34	3.72
PAMATAI II	3.97	1.34	1.98
PANAGYURISHTE	2.63	0.84	2.50
PARAMARIBO	3.79	1.61	2.78
PATRICK	9999.00	9999.00	9999.00
PATRONY	2.78	1.43	3.11
PENDELI	9999.00	9999.00	9999.00
PILAR	4.78	1.59	3.44
PIONERSKAYA	9999.00	9999.00	9999.00
PLAISANCE	9999.00	9999.00	9999.00
PLATEAU	0.12	8.02	15.78
PLESHENITZI	2.31	4.38	2.49
PORT MORESBY	2.21	1.60	4.58
PORT-ALFRED	2.22	1.57	2.67
PRICE	9999.00	9999.00	9999.00
PRUHONICE	3.06	1.02	3.71
QUETTA	5.78	7.06	6.51
REGENSBERG	2.73	1.86	3.19
RESOLUTE BAY	2.20	2.18	6.76
ROBURENT	4.04	22.09	6.98
ROI BAUDOUIN	0.67	1.86	1.70
RUDE SKOV	2.14	1.14	2.36
SABHAWALA	8.85	5.99	9.82
SAN FERNANDO	3.70	3.36	17.15
SAN JOSE LAS LA	14.56	2.82	101.03
SAN JUAN	3.84	1.30	3.16
SAN JUAN II	3.05	0.89	3.27
SAN MIGUEL III	5.24	14.55	3.29
SANAE	4.64	13.43	7.17
SCOTT BASE	8.25	4.81	18.79
SHESHAN	3.22	2.34	2.45
SHILLONG	4.68	2.38	0.71
SIMFEROPOL	9999.00	9999.00	9999.00
SIMOSATO	3.56	1.47	1.91
SITKA	2.24	1.31	2.24

SODANKYLA	2.83	1.31	2.88
SOUTH GEORGIA	4.57	3.17	2.57
SOUTH POLE	5.00	5.06	11.67
SREDNIKAN IV	6.37	2.49	13.26
STEKOLINIY	2.74	1.76	2.36
STEPANOVKA	2.69	1.10	3.29
STONYHURST	3.19	9.57	2.83
SURLARI	8.88	2.44	18.22
SWIDER	2.39	0.97	7.13
SYOWA BASE	3.13	8.86	11.35
TAHITI	9999.00	9999.00	9999.00
TAMANRASSET	6.62	9.97	14.19
TANANARIVE	4.79	2.97	7.43
TANGERANG	26.70	14.07	43.78
TATUOCA	5.15	2.33	5.57
TEHRAN	4.92	3.50	7.66
TEHRAN II	9999.00	9999.00	9999.00
TENERIFE	9.17	10.70	14.67
TEOLOYUCAN	16.56	11.22	20.84
THULE II	1.43	0.87	4.68
TIHANY	4.45	2.07	4.57
TIKHAYA BAY	0.97	1.43	0.47
TIKSI	4.97	1.35	9.00
TOLEDO	3.17	1.19	5.87
TOMSK	4.22	1.81	6.39
TOOLANGI	1.58	1.30	1.67
TRELEW	3.37	2.76	2.25
TRIVANDRUM	5.51	7.37	5.38
TROMSO	3.97	1.76	5.17
TSUMEB	2.82	1.19	1.64
TUCSON	2.89	0.94	2.27
TULSA	9999.00	9999.00	9999.00
UELEN	4.75	10.61	5.52
UJJAIN	12.76	3.68	7.07
ULAN BATOR	11.40	1.92	2.89
URUMQI	9999.00	9999.00	9999.00
VALENTIA	2.06	0.92	1.62
VANNOVSKAYA	4.42	2.79	6.00
VASSOURAS	4.20	1.68	2.57
VICTORIA	3.02	1.57	2.87
VOROSHILOV	5.21	0.27	0.0
VOSTOK	11.89	8.99	14.45
VOYEYKOVO	2.54	1.19	3.25
VYKHODNOY	9999.00	9999.00	9999.00
VYSOKAY DUBRAVA	2.37	0.94	5.94
WATHEROO	3.63	1.56	7.82
WIEN KOBENZL	2.29	0.93	1.97
WILKES	5.37	3.33	11.61
WINGST	1.75	0.80	2.38
WITTEVEEN	3.66	1.00	2.24
WUHAN	9999.00	9999.00	9999.00

YAKUTSK	3.93	2.34	5.80
YANGI-BAZAR	3.11	0.97	3.32
YELLOW-KNIFE	2.74	3.15	5.39
YUZHNO SAKHALSK	3.13	1.46	1.18
YUZHNO SAKH II	3.89	2.35	4.28
YUZHNO SAK III	5.45	6.38	2.87
ZAYMISHCHE	3.49	1.02	4.41
ZUY	4.07	0.87	2.54

```
// EXEC NOTIFYTS
```

..... STAGE 2 Run Deck with source deck .....

```
//XRJRRXYZ JOB (F8002,X22,50),STEP2B,TIME=(6,0),NOTIFY=XRJRR,CLASS=0,
//  MSGCLASS=X
/*JOBPARM LINES=60
//* XRJRR.DTAPE.PROCESS(STEP2B)
//* TEST FOR EULER ANGLE, BIAS SOLUTION.  MARCH 19-21, 1984
// EXEC SYSIN
//SYSIN DD DSN=XRJRR.FIT.FILES(UPDMSP2),DISP=SHR
//TPSY EXEC PGM=TPSYS,REGION=150K
//STEPLIB DD DSN=YCWDW.TPSYS.LOAD,DISP=SHR
//FT10F001 DD DSN=YCDMM.FIT.FORT,UNIT=SYSDA,DISP=SHR
//FT11F001 DD UNIT=SYSDA,DSN=YCDMM.FIT.SRCE,SPACE=(CYL,(5,1),RLSE),
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=7280),DISP=(,PASS)
//FT06F001 DD SYSOUT=*
//FT05F001 DD DISP=SHR,DSN=&&DATA5
// EXEC OFORTH,PARM='XREF,LINECNT=60',REGION=2000K
//SYSIN DD DISP=(OLD,DELETE),DSN=YCDMM.FIT.SRCE
//RESULT EXEC OLINKH,COND=(9,LT)
//NEWLIN DD DSN=YCWDW.FITQ.LOAD,DISP=SHR
//SYSLMOD DD DSN=YCDMM.FTT.LOAD,DISP=(,PASS)
//OBJECT DD *
 INCLUDE NEWLIN(FIT8305)
 ENTRY MAIN
 NAME FIT(R)
//REALY EXEC PGM=FIT,REGION=3000K
//STEPLIB DD DISP=SHR,DSN=YCDMM.FTT.LOAD
//GO.FT01F001 DD UNIT=SYSDA,SPACE=(CYL,(7,2),RLSE),
//   DCB=(RECFM=VBST,LRECL=200,BLKSIZE=12004)
//GO.FT02F001 DD UNIT=SYSDA,SPACE=(CYL,(7,2),RLSE),
//   DCB=(RECFM=VBST,LRECL=200,BLKSIZE=12004)
//GO.FT06F001 DD SYSOUT=*
//GO.FT07F001 DD DUMMY,SYSOUT=B,DCB=(RECFM=FB,LRECL=80,BLKSIZE=7280),
//   SPACE=(CYL,(0,1),RLSE)
//GO.FT10F001 DD DUMMY,DSN=POG6CQ,UNIT=(9TRACK,,DEFER),DISP=(OLD,KEEP),
// DCB=(RECFM=VBS,LRECL=4004,BLKSIZE=4008),LABEL=(1,SL,,IN),
// VOL=SER=MAG001
//GO.FT10F002 DD DUMMY,DSN=POG6MQ,UNIT=(9TRACK,,DEFER),DISP=(OLD,KEEP),
// DCB=(RECFM=VBS,LRECL=4004,BLKSIZE=4008),LABEL=(2,SL,,IN),
// VOL=SER=MAG001
//GO.FT10F003 DD DUMMY,DSN=POG246,UNIT=(9TRACK,,DEFER),DISP=(OLD,KEEP),
// DCB=(RECFM=VBS,LRECL=4004,BLKSIZE=4008),LABEL=(3,SL,,IN),
// VOL=SER=MAG001
//FT11F001 DD DSN='XRJRR.FIT.OUT.NMATX',DISP=SHR
//FT12F001 DD UNIT=SYSDA,DISP=(,PASS),SPACE=(TRK,(90,20),RLSE),
//       DCB=(RECFM=VBS,LRECL=100,BLKSIZE=7204)
//GO.FT13F001 DD DUMMY
//FT15F001 DD DUMMY
//FT16F001 DD DUMMY
//FT17F001 DD DUMMY
//FT18F001 DD DUMMY
//*
```

```
//* BINARY INPUT DATA FOLLOWS.
//FT20F001 DD DSN=XRJRR.MAR1984.STEP1.OUTBIN,DISP=SHR
//*
//FT22F001 DD UNIT=SYSDA,DISP=(,PASS),SPACE=(TRK,(40,10),RLSE),
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=7200)
//FT23F001 DD UNIT=SYSDA,DISP=(,PASS),SPACE=(TRK,(40,10),RLSE),
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=7200)
//FT24F001 DD UNIT=SYSDA,DISP=(,PASS),SPACE=(TRK,(40,10),RLSE),
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=7200)
//*
//*  OUTPUT COEFFICIENTS FOLLOW.
//FT25F001 DD DUMMY,DSN=XRJRR.FIT.DMSP.COEFFS,UNIT=SYSDA,DISP=SHR
//*VOL=SER=SACC09,DCB=(RECFM=FB,LRECL=80,BLKSIZE=8000),
//*SPACE=(TRK,(2,2),RLSE),DISP=(NEW,CATLG)
//*
//FT35F001 DD DUMMY
//FT36F001 DD DUMMY
//FT40F001 DD DUMMY
//FT41F001 DD DUMMY
//FT45F001 DD DUMMY
//FT46F001 DD DUMMY
//FT65F001 DD DUMMY
//SYSUDUMP DD DUMMY
//FT05F001 DD *
 &CONTRL     NSIML=0, IRSTRT=0,NOISE=0,RTIM=9999.,
 EULER=2,IBIAS=1,
      ITER=2,
 NSKIP=1,
 &END
 DMSP MAR19-21, 1984 SOLVE FOR EU ANGLES, BIASES. LAT CUT=75, DEGREE=4.
 &FIELD    MONO=2,
  NMAXR=0,    NMAXTR=0,
 BGNTIM=0.,
 EXTFLD=0,NEXT=0
 PRCORL=4,
 IDST=0,
 EPOCH=1984.22,AVETIM=1984.22,
 NMAX=11,NMAXT=9,NMAXTT=0,NMXTTT=0,NMAXIV=0,NMAXV=0,
 &END
 &LIMERR ERRLIM=2*90.,8*1000.,            3*1000.,2*.0012,2*30.,
 NTDATA=1,NAT(1)=8,NAT(2)=2,APRIOR=0,
 NSTOP=0,
 AYSTAT=1,  BIASAP=5000.,
    NDGEN=5,  &END
  2  1-29878.2    0.000000E+00 26.9879    0.000000E+000.000000E+000.000000E+00
  2  2-1924.05     5526.55     7.95582    -19.3154     0.000000E+000.000000E+00
```

C. STAGE 3 is a simple program to change the format of the SHA coefficients.

...... Run Deck for STAGE 3 ....

```
//XRJRRST3 JOB (F8002,X22,10),STEP3,TIME=(0,10),CLASS=0,MSGCLASS=X,
//   NOTIFY=XRJRR
//*  STEP3.  INPUT IS "COEFFS" FILE ON UNIT #25 FROM STEP2.
//* THIS PROGRAM READS GAUSS COEFFICIENTS IN FIT FORMAT AND WRITES
//*  THEM OUT IN FID FORMAT.
// EXEC FORTRAN,PARM='XREF'
//SYSIN DD *
      INTEGER WORD(20)
      DATA NZERO/0/,MZERO/0/
C  SET SOME MORE FID PARAMETERS
      DATA MODEXT/0/,K/0/,ABAR/6371.2/,MODIND/0/
C  READ IN TITLE FROM FIT FORMAT DATA, ON UNIT #1.
      READ(1,101) (WORD(I),I=1,20)
  101 FORMAT(20A4)
C  READ IN FIT INPUT PARAMETERS
      READ(1,102) NMAX,NMAXT,NMAXTT,NMAXT3,EPOCH
  102 FORMAT(4I2,16X,F10.0)
C*** NOTE:  FOR THIS VERSION OF THE PROGRAM ONLY, SET NMAXT=9. ****
      NMAXT=9
C  WRITE OUT FID PARAMETERS
      WRITE(2,201) NMAX,NMAXT,NMAXTT,NMAXT3,MODEXT,K,EPOCH,ABAR,
     > MODIND
  201 FORMAT(6I2,2F6.1,I2)
C  WRITE OUT TITLE
      WRITE(2,101) (WORD(I),I=1,20)
      ICOUNT=0
C  READ IN GAUSS COEFFICIENTS AND WRITE OUT
    1 READ(1,103) N,M,G,H,GT,HT,GTT,HTT
  103 FORMAT(2I3,6F12.0)
      WRITE(2,203) N,M,G,H,GT,HT,GTT,HTT
  203 FORMAT(2I3,6F11.4)
C
      IF (N .LT. NMAX) GO TO 3
      IF (M .LT. NMAX) GO TO 3
        GO TO 5
C
    3 ICOUNT = ICOUNT + 1
      NF = N
      MF = M
      GO TO 1
C
    5 ICOUNT = ICOUNT + 1
C  PUT ZEROS AT THE BOTTOM OF THE DATA LIST
      WRITE(2,203) NZERO,MZERO
      WRITE(2,203) NZERO,MZERO
        NF = N
        MF = M
      WRITE(6,601) ICOUNT,NF,MF
```

```
  601 FORMAT(///,10X,'NUMBER OF COEFFICIENTS IS: ',I3,/,
     > 10X,'MAX DEGREE= ',I3,3X,'MAX ORDER= ',I3)
C
      STOP
      END
// EXEC LINKGO,REGION.GO=200K
//GO.FT01F001 DD DSN=XRSHS.JAN1885.STEP2.COEFFS,DISP=SHR
//GO.FT02F001 DD DSN=XRSHS.JAN1885.STEP3.COEFFS,DISP=(NEW,CATLG),
//  DCB=(RECFM=FB,LRECL=80,BLKSIZE=8000),SPACE=(TRK,(2,2),RLSE),
//  VOL=SER=SACC01,UNIT=SYSDA
// EXEC NOTIFYTS
```

VI. Further Data Processing

Each of these sets was then further processed by rejecting data with high K_p or large DST indices. The DST index was added to each data point, and data in each set were sorted by geographical location (equal area bin). Finally, data in each bin were rejected, until a specified number (9 for dip-latitude > 30 degrees, 3 for dip-lat < 30) per bin was obtained. The 15 sets were then concatenated into a single file, ready for input into the FIT program.

Table 2 summarizes this process and indicates the input and output data sets used in the various programs.

Programs and Processing Steps

TABLE 2: PROCESSING OF DMSP DATA IN PREPARATION FOR FIELD MODELING

PROGRAM	INPUT	OUTPUT	FUNCTION
DSTADD	DATE.STEP5.OUTBIN Dst tape	TEMPFILE #1	Adds DST values, equal-area geographic bin numbers to data. Reject selected lengths of data with high K_p and large DST indices. Sorts data by bin number.
BINSIFT	TEMPFILE #1	DATE.SIFT.DATA (VBS,lrecl=116, Blksize=11604)	Reduces the # of points in each equal-area bin down to a specified level. Point rejection criteria: 1) points flagged by STEP5, 2) DST beyond the -5 to 20 nT range, 3) Random rejection.

The output from this program, DATE.SIFT.DATA, becomes file 6 on the output tape.

PROGRAM	INPUT	OUTPUT	FUNCTION
FITPREP	DATE.SIFT.DATA (14 separate dates)	DMSP.FITPRP (VBS,lrecl=11204, Blksize=22412)	Concatenates individual data sets into 1 file; puts data into FIT format (100 points per logical record).

EUTRANS			
	DMSP.FITPRP	TEMPFILE #2	Applies calibration values calculated in a FIT run to update the data.
XYZTRANS			
	TEMPFILE #2	DMSP.FITXYZ (VBS,lrecl=11204, Blksize=22412)	Transforms spacecraft coordinates to XYZ (topocentric) coordinates. Data is in old FIT format.

Format Information

XRJRR.DMSP.FITPRP - Same format as File#6, except that data have been re-concatenated into 100 points per record.

XRJRR.DMSP.FITXYZ - Same format as DMSP.FITPRP, except that A(11,I) holds X (north) component in topocentric coordinates, A(12,I) holds Y (east) component, A(13,I) holds Z (radial) component.

VII. Data Tapes and Cartridges

Programs and Related Information

All programs and related data sets known to be relevant to DMSP data processing and evaluation have been collected and saved on Cartridge S01000. TABLE 3 summarizes the contents of this cartridge.

Note that particular JCL was necessary to copy a load module onto the cartridge and that restoration of that load module also requires specific JCL. This JCL is given as follows:

1) To copy an IBM load module from a partitioned data set on a disk to a tape or cartridge file:

```
//XR1RBFAT JOB (F8002,X22,10),'IEBCPY', CLASS=A,
//     MSGCLASS=X,TIME=(,30),NOTIFY=XR1RB
/*JOBPARM LINES=50
//*  XR1RB.LIB.CNTL(IEBCPY)
//*==============================================================
===
//*
//* THIS COPIES A LOAD MODULE ON DISK TO TAPE OR CARTRIDGE
//*
//*==============================================================
===
//       EXEC PGM=IEBCOPY
//SYSPRINT DD SYSOUT=*
//SYSIN    DD DUMMY
//SYSUT1   DD   DISP=SHR,DSN=XRJRR.FIT.DMSP.LOAD2
//SYSUT2   DD   DISP=(NEW,PASS),
//      UNIT=3480,VOL=SER=S01000,LABEL=(4,SL,,OUT),
//      DSN=OLDFIT3
/*
```

2) To copy a load module on a tape or cartridge file to a partitioned data set on disk.

```
//XR1RBFAT JOB (F8002,X22,10),'CPYDSK',CLASS=A,
//      MSGCLASS=X,TIME=(,30),NOTIFY=XR1RB
/*JOBPARM LINES=50
//*   XR1RB.LIB.CNTL(CPYDSK)
//*===============================================================
//*
//* THIS COPIES A LOAD MODULE ON TAPE OR CARTRIDGE TO DISK
//*   PARTITIONED
//*===============================================================
//       EXEC PGM=IEBCOPY
//SYSPRINT DD SYSOUT=*
//SYSIN    DD DUMMY
//SYSUT1   DD   DISP=(NEW,PASS),
//      UNIT=3480,VOL=SER=S01000,LABEL=(4,SL,,IN),
//      DSN=OLDFIT3
//SYSUT2 DD DSN=XR1RB.TEMPORY.NAME,SPACE=(TRK,(14,5,1),RLSE),
//          DISP=(NEW,CATLG),DCB=(RECFM=U,BLKSIZE=19069),UNIT=SYSDA
```

TABLE 3: CONTENTS OF CARTRIDGE S01000
PROGRAMS AND DATA FOR PROCESSING DMSP DATA

FILE	PROGRAM NAME OR IDENTIFIER	SOURCE	COMMENTS
.....	Basic Filter Program		
1	FILTER	XRTJS.DMSP.FILT.CNTL	
.....	Files for old FIT Program		
2	OLD FIT ONE	XRJRR.FIT.FILES(UPDMSP2)	Update Deck
3	OLD FIT TWO	YCDMM.FIT.FORT	Standard Fit Source Code
4	OLD FIT THREE	XRJRR.FIT.DMSP.LOAD2	Load Module for fit used for DMSP
5	OLD FIT FOUR	YCWDW.TPSYS.LOAD	Standard Update Sys.
6	OLD FIT FIVE	YCWDW.FITQ.LOAD	Contains additional FIT items such as assembler version of DLOOP and FMOVE, FREAD, etc.
....	Program to reformat SHA Coefficients		
7	STEP3	XRJRR.DTAPE.PROCESS(STEP3)	STAGE3 Run Deck
.....	Programs to work with cleaned up data		
8	BINSIFT	XRJRR.DTAPE.PROCESS(BINSIFT)	Run Deck
9	DSTADD	XRJRR.DTAPE.PROCESS(DSTADD)	Run Deck
10	FITPREP	XRJRR.DTAPE.PROCESS(FITPREP)	Run Deck
11	EUTRANS	XRJRR.DTAPE.PROCESS(EUTRANS)	Run Deck
12	XYZTRANS	XRJRR.DTAPE.PROCESS(XYZTRANS)	Run Deck
......	Deck Setups for the STAGES of Table 1		
13	STEP1	XRJRR.DTAPE.PROCESS(STEP1)	Run Deck for STAGE1
14	STEP2	XRJRR.DTAPE.PROCESS(STEP2)	Run Deck for STAGE2, using Load Module
15	STEP2B	XRJRR.DTAPE.PROCESS(STEP2B)	Run Deck for STAGE2, using source module
16	STEP4	XRJRR.DTAPE.PROCESS(STEP4)	Run Deck for STAGE4
17	STEP5	XRJRR.DTAPE.PROCESS(STEP5)	Run Deck for STAGE5
.....	Source and Load Modules for Stages 1, 4, and 5		
18	CODE1	XRJRR.DTAPE.PROCESS	Modified source code of FILTER and of BSPLYNE3 for DMSP processing.
19	SATFILT	XRJRR.SATFILT	Load module containing DMSP version of FILTER and BSPLINE.

....	Data or Model Input		
20	CAL84FID	XRJRR.DTAPE.PROCESS(CAL84FID)	Initial field model
21	DST81	XRJRR.DST81	Yearly Dst
22	FITPRP	XRJRR.DMSP.FITPRP	Output Data
23	FITXYZ	XRJRR.DMSP.FITXYZ	Output Data
24	BSPINFO	XRTJS.BSPINFO.DATA	Bspline and Fourier parameters
......	Miscellaneous Ridgway Programs		
......	From XRJRR.DMSP.PROGRAMS(....)		
25	ADDFLAG		Flags Bspline outliers from FILTER before plotting
26	ADDFLAG2		Same as ADDFLAG, except all bad points flagged
27	BSIG		Computes stastics on DMSP data relative to selected field model.
28	LOOK		Printout of STAGE5 output.
29	POWPLT		Power spectrum plotting routine.
....	DMSP version of the BSPLINE Program		
30	BSPLINE	XRTJS.LIB.MAG(BSPLYN3)	General program for B-Spline and Fourier fitting.

Processed Data

The following Table is a list of the original tapes as received from AFGL and a list of the tapes onto which the data was processed. The processed data tape is a six file tape; the formats of the six files are described in the following paragraphs. For permanent storage, the tapes were copied onto the indicated Cartridge: the first cartridge file contains the contents of the (one file) raw data tape from AFGL; the second through seventh cartridge files are files one through six of the processed data tape.

DATE	RAW DATA TAPE FROM AFGL	TAPE ON WHICH PROCESSED DATA IS STORED	CARTRIDGE ON WHICH TAPES ARE COPIED
1/7-9/84	DT0030	DT0119	S01011=S01012
1/17-18/84	MAG025,MAG026	DT0120	S01013=S01014
3/19-21/84	DT0031	DT0121	S01015=S01016
5/6-8/84	DT0105	DT0122	S01017=S01018
(Data on these dates was "bad", not used in final modeling)			
6/20-23/84	DT0106	DT0123	S01019=S01020
8/20-23/84	DT0107	DT0124	S01021=S01022
9/16,17/84	DT0108	DT0125	S01023=S01024
1/18-20/85	DT0109	DT0127	S01025=S01026
5/23-25/85	DT0111	DT0128	S01027=S01028

6/13-15/85	DT0112	DT0129	S01029=S01030
6/16-19/85	DT0113	DT0130	S01031=S01032
8/5-7/85	DT0114	DT0131	S01033=S01034
9/29-30/85	DT0115	DT0132	S01035=S01036
10/26-28/85	DT0117	DT0134	S01039=S01040
11/23-25/85	DT0118	DT0135	S01041=S01042

The input tapes from AFGL were one file of ASCII data with the following format:

Tape characteristics: Non-labeled, 6250 BPI, Recfm=FB, Lrecl=75, Blksize = 1875, ASCII (OPTCD=Q).

Data format:

Header record -- every 60 seconds:

COLS	VARIABLE	TYPE	DESCRIPTION
1-4	IYR	INT	Year
5-8	IDAYD	INT	Day number
9-14	IETIME	INT	Time of record (seconds U.T.)
15-18	IALT	INT	Altitude (Nautical miles)
19-28	GLAT	REAL	Geographic latitude.
29-38	GLONG	REAL	Geographic longitude.
39-48	GMLAT	REAL	Corrected geomagnetic latitude.
49-58	GMLONG	REAL	Corrected geomagnetic longitude.
59-68	XMLT	REAL	Corrected geomagnetic local time.
72-75	NS	INT	Number of data records following header (usually = 60).

Data record -- every second

COLS	VARIABLE	TYPE	DESCRIPTION
1-6	IDSEC	INT	Time of data record(sec U.T.) (I6)
12-29	X1,Y1,Z1	INT	Magnetometer counts for first of 20 samples per second; 3 axes (3I6).
34-51	X2,Y2,Z2	INT	Magnetometer counts for eleventh of 20 samples per second; 3 axes (3I6).
56-75	NF(1-10)	INT	Ten data quality flags (10I2).

The raw data tape from AFGL becomes the first file, ASCII, on the output cartridge. Files 1 through 5 on the output tape become files 2 through 6 on the cartridge. File 6 on the output tape, to be described later in this Section, becomes file 7 on the cartridge.

Storage of processed data: On the "processed data" tapes, and corresponding cartridges, the files are set up as follows (add one file number for cartridge files):

File#	Data File	File characteristics
1	DATE.STEP2.COEFFS	FB, Lrecl=80, Blksize=5440
2	DATE.STEP3.COEFFS	FB, Lrecl=80, Blksize=5520
3	DATE.STEP4.OUTF	FB, Lrecl=240,Blksize=4800
4	DATE.STEP5.OUTBIN	VBS, Lrecl=11204, Blksize=22412
5	DATE.STEP5.OUTF	FB, Lrecl=240,Blksize=4800.
6	DATE.SIFT.DATA	VBS,Lrecl=116,Blksize=11604

Formats of processed data files:

i) File #1 - Standard FIT coefficient format.

ii) File #2 - Standard FDG coefficient format.

iii) File #3,5 - Fixed block format:

COLUMNS	TYPE	FORMAT	DESCRIPTION
1-2	INT	I2	Year
3-6	INT	I4	Day.
7-12	INT	I6	Seconds of day.
13-19	Real	F7.2	Geographic latitude.
20-26	Real	F7.2	Geocentric latitude.
27-33	Real	F7.2	Longitude.
34-40	Real	F7.2	Dip-latitude.
41-47	Real	F7.2	Dip-longitude.
48-54	Real	F7.2	Altitude.
55-61	Real	F7.2	Geocentric Radius.
62-69	Real	F8.1	Crosss-track spacecraft mag. component.
70-77	Real	F8.1	Radial spacecraft mag. component.
78-85	Real	F8.1	Along-track spacecraft mag. component.
86-93	Real	F8.1	Total field intensity.
94-101	Real	F8.1	Residual cross-track component.
102-109	Real	F8.1	Residual radial " .
110-117	Real	F8.1	Residual along-track " .
118-125	Real	F8.1	Residual total field intensity.
126-133	Real	F8.1	X (north) component.
134-141	Real	F8.1	Y (east) component.
142-149	Real	F8.1	Z (down) component.
150-157	Real	F8.1	Total field intensity.
158-165	Real	F8.1	Residual X component.
166-173	Real	F8.1	Residual Y component.
174-181	Real	F8.1	Residual Z component.
182-189	Real	F8.1	Residual total field intensity.
190-197	Real	F8.1	Model field, X component.
198-205	Real	F8.1	Model field, Y component.
206-213	Real	F8.1	Model field, Z component.
214-221	Real	F8.1	Model field, total intensity.
222-226	INT	I5	Velocity direction flag (=+,-1)
227-231	INT	I5	Data quality flag (=0 if good, 1-7 if bad).
232-239	INT	4I2	Data indicator flags for X,Y,Z,B.

iv) File #4 - Binary FIT format (100 points per record, 28 real*4 words per point):

One of the common formats into the (old) field modeling program is called FIT format. Data from the POGO, Magsat and DMSP F-7 satellites are generally in this format, or a variation therof. These files are binary with 100 points per record and with each point having 28 REAL*4 words of data, as follows:

```
REAL*4 A(28,100)
INTEGER IA(28,100)
EQUIVALENCE (A(1,1), IA(1,1))
```

ARRAY LOCATION	DESCRIPTION
IA(1,I)	Modified Julian Day.
IA(2,I)	Milliseconds of Day.
A(3,I)	Not used.
A(4,I)	In some cases not used, in others fraction of day.
A(5,I)	Time in years from 1900.
A(6,I)	Geocentric latitude.
A(7,I)	Longitude.
A(8,I)	Not used.
A(9,I)	Not used.
A(10,I)	Not used.
- - - - - - - - - -	- - - - - - - -
If data are in geocentric coordinates:	
A(11,I)	North component, $-B\theta$, or Satellite X-axis component.
A(12,I)	East component, $B\phi$, or Satellite Y-axis component.
A(13,I)	Satellite Z-axis component (along-track).
- - - - - - - - - -	- - - - - - - -
If data are in spacecraft coordinates:	
A(11,I)	Cross track component
A(12,I)	Radially down component
A(13,I)	Along track component
- - - - - - - - - -	- - - - - - - -
A(14,I)	Scalar total intensity.
IA(15,I)	Geocentric altitude (meters) above earth radius, earth radius taken to be 6371.0 km. (Note: this standard Earth radius was used for Magsat. Other data used 6371.2. User beware.)
A(16,I)	Not used.
A(17,I)	Not used.

IA(18,I)	Used only for DMSP = Data quality classification flag (0-7): 0 = Data is adequate quality 1 = Residual from field model exceeds a specified cutoff (Gross outlier) 2 = Padded time gap value (data does not actually exist here on tape.) 3 = Outlier from B-spline function 4 = Outlier from Fourier function 5 6 = Latitude of data exceeds specified geocentric latitude cutoff. 7 = Direction of satellite indeterminable
IA(19,I)	=0
IA(20,I)	=0 except for DMSP where it indicates satellite velocity vector direction (=+,-1), + means going north; - means going south, if zero the direction is undetermined.
IA(21,I)	=0
IA(22,I)	Magnetic latitude outlier flag for sat. X axis. (0 = no data; 2 = data)
IA(23,I)	" " " " " " Y " (0 = no data; 2 = data)
IA(24,I)	" " " " " " Z " (0 = no data; 2 = data)
IA(25,I)	" " " " " total intensity.
A(26,I)	Not used.
A(27,I)	Not used.
A(28,I)	Not used.

v) File #6 - Binary "pseudo-FIT" format (1 point per record, 28 real*4 words per point): Same as FIT format, except that IA(16) holds the geographic equal-area bin number, and IA(17) holds the DST hourly index.

Unprocessed Data

The following Table is a list of original tapes from AFGL which were received after processing was suspended.

DATE	RAW DATA TAPE FROM AFGL	CARTRIDGE ON WHICH TAPES ARE COPIED
10/1/85	DT0116	S01037=S01038
10/16-18/84	DT0181 (M4784)	S01043=S01044
1/11-14/86	DT0182 (M5098)	S01045=S01046
3/9-12/86	DT0183 (M5097)	S01047=S01048
5/13-15/86	DT0184 (M4785)	S01049=S01050
5/28-30/86	DT0185 (M5099)	S01051=S01052
6/25-26/86	DT0186 (M5100)	S01053=S01054
7/14-15/86	DT0187 (M5101)	S01055=S01056
7/16	DT0188 (M5102)	S01057=S01058
8/16-18/86	DT0189 (M5103)	S01059=S01060
9/8/86	DT0190 (M5218)	S01061=S01062
9/16,22/86	DT0191 (M5104)	S01063=S01064
10/10-12/86	DT0192 (M5215)	S01065=S01066
11/8-10/86	DT0193 (M5216)	S01067=S01068
11/21-23/86	DT0194 (M5217)	S01069=S01070
12/5-6/86	DT0195 (M5270)	S01071=S01072
???????????	DT0196 (M4050)	S01073=S01074
2/15/85	DT0216 (M4786)	S01075=S01076
4/18/85	DT0217 (M4788)	S01077=S01078
2/16/86	DT0218 (M4787)	S01079=S01080

These tapes and cartridges are one file, ASCII, in the same format as the first file on the tapes with processed data.

VIII. Individual Epoch DMSP Field Models

The correction procedure was applied to 15 sub-sets of DMSP data, each containing several days of data. These are the data in the processed tapes and cartridges of the previous section. Subset epochs ranged from January, 1984 through November, 1985. Each data set was chosen from a magnetically quiet period as determined by the world-wide K_p index. Results of STAGE 2, which solves for the field model and magnetometer adjustment parameters, are summarized in Table 4.

Table 4

Date yrs	g_1^0 nT	g_1^1 nT	h_1^1 nT	ϵ_x deg	ϵ_y deg	ϵ_z deg	BIAS1 nT	BIAS2 nT	BIAS3 nT
84.02	-29895	-1927	5522	-.038	-.449	0.005	12.0	2.6	-1.7
84.05	-29893	-1928	5532	-.065	-.446	0.006	0.2	-.5	1.4
84.21	-29887	-1935	5523	-.114	-.459	-.004	7.8	2.7	-8.7
84.34	-29872	-1925	5516	-.172	-.457	-.013	11.4	-2.0	-12.5
84.47	-29860	-1922	5514	-.138	-.451	-.016	2.4	-7.6	-11.2
84.63	-29866	-1932	5503	-.063	-.474	-.009	-11.9	-12.1	-3.8
84.71	-29866	-1927	5505	-.092	-.478	-.006	-18.4	-9.5	-2.4
85.05	-29857	-1918	5496	-.050	-.496	-.022	-91.2	-56.7	20.0
85.34	-29856	-1910	5492	-.129	-.471	-.013	-91.2	-67.0	4.1
85.45	-29838	-1920	5494	-.125	-.467	-.017	-93.6	-68.3	1.3
85.46	-29843	-1916	5491	-.130	-.472	-.020	-86.7	-65.9	1.3
85.60	-29842	-1915	5495	-.098	-.475	-.009	-100.4	-74.2	4.6
85.75	-29847	-1908	5490	-.074	-.520	0.013	-112.6	-72.3	7.3
85.82	-29843	-1914	5484	-.081	-.511	0.021	-113.1	-63.7	12.8
85.90	-29832	-1905	5489	-.030	-.518	0.032	-110.0	-57.5	25.7

Figures 4a) through 4e) are derived from Table 4. They display solutions for g_1^0, g_1^1, h_1^1, the three Euler angles, and the three biases for each DMSP data set throughout time. The main field coefficients decrease in magnitude with time as expected from earlier models, but the trend is not smooth. This could indicate that the data sub-sets have marginal geographic distribution, or that the DMSP data are not sufficiently stable over time. The Euler angle solutions are fairly consistent, with ϵ_y (yaw) varying slowly from -.44 to -.52 degrees, ϵ_x (pitch) averaging about -.1 degrees and ϵ_z (roll) averaging about zero. The bias values show a noticeable break between September, 1984 and January, 1985, most strongly in X and Y. Biases at January, 1985 depart sharply from the previous bias trend in all three components. This jump is evident in the biases only, and its cause is uncertain. One possible explanation is that on 30 October, 1984, the solar array panel was rotated 90°. This could result in a changed contribution to the bias field from the solar array since both its position and its total current were changed. Another, though less likely, spacecraft change that could contribute to the bias change is that on 7 November, 1984, the skew momentum wheel was reset so that it drew 100 ma less current.

The bias values in Table 4 are part of the value of the vector parameter **bias** to be used in equation 3), i.e. they are a small time dependent correction to be applied in addition to the large bias values of equation 2). A small further correction is derived in section IX of paper 1.

Figure Captions

Figure #	Caption
1	DMSP orbital X, Y, and Z magnetic component data which have had an estimated field model removed, revealing strong periodicities in the residuals. The dashed line is a spline fit to the residuals.
2	Power spectra of X and Y DMSP residual data from Figure 1.
3	Y-component of DMSP data from Figure 1, demonstrating removal of outliers, magnetometer rotation and bias correction, and subtraction of Fourier periodic function. The dashed line is a spline fit to the residuals.
4	Plots of g_1^0, g_1^1, h_1^1, Euler angles, and biases versus time (yrs), for field model solutions from 15 DMSP data sets spanning 1984 - 1986.

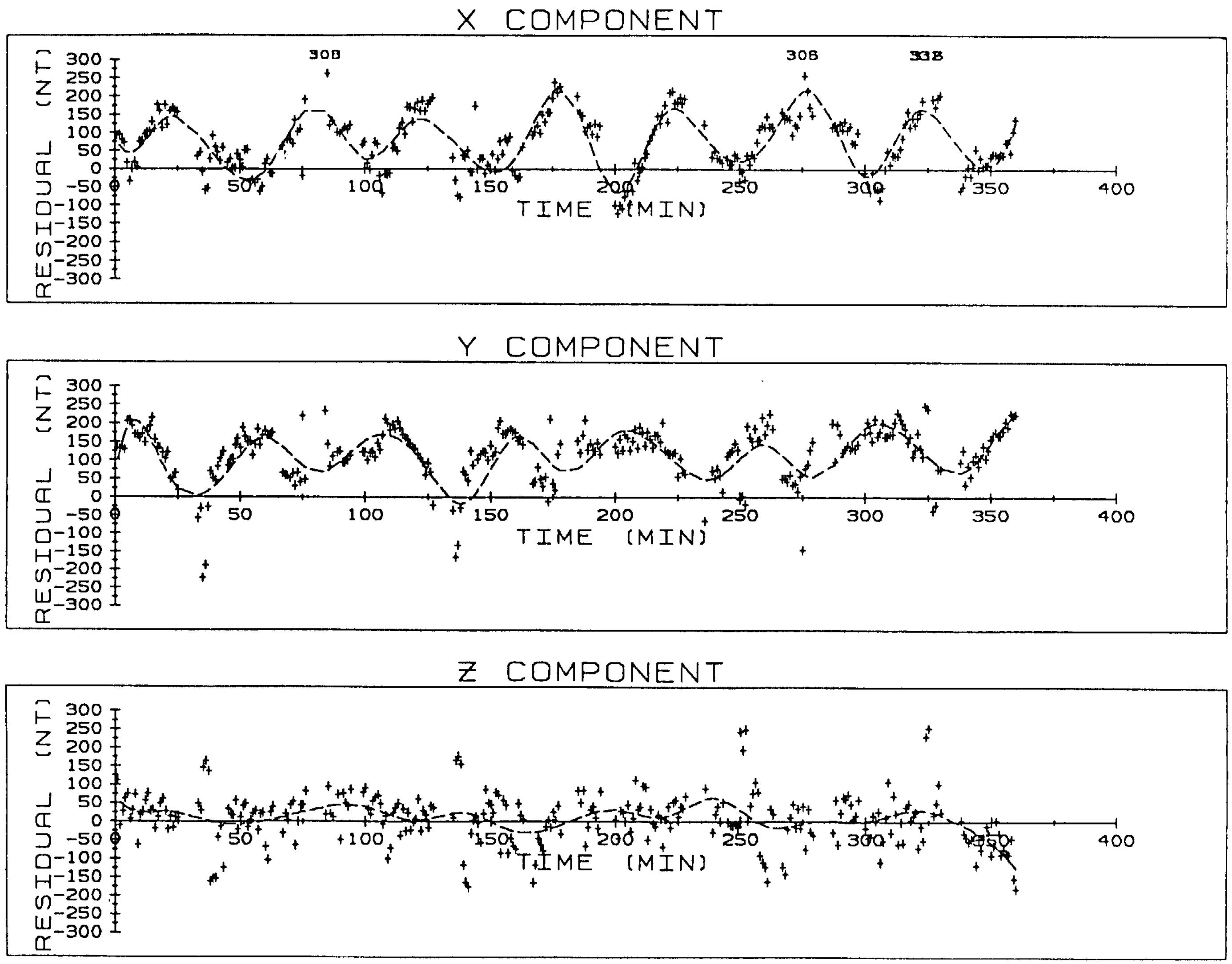

X COMPONENT
Y COMPONENT
Z COMPONENT
RESIDUAL (NT)
TIME (MIN)
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
50
100
150
200
250
300
350
400
308
306
338

FIGURE 1

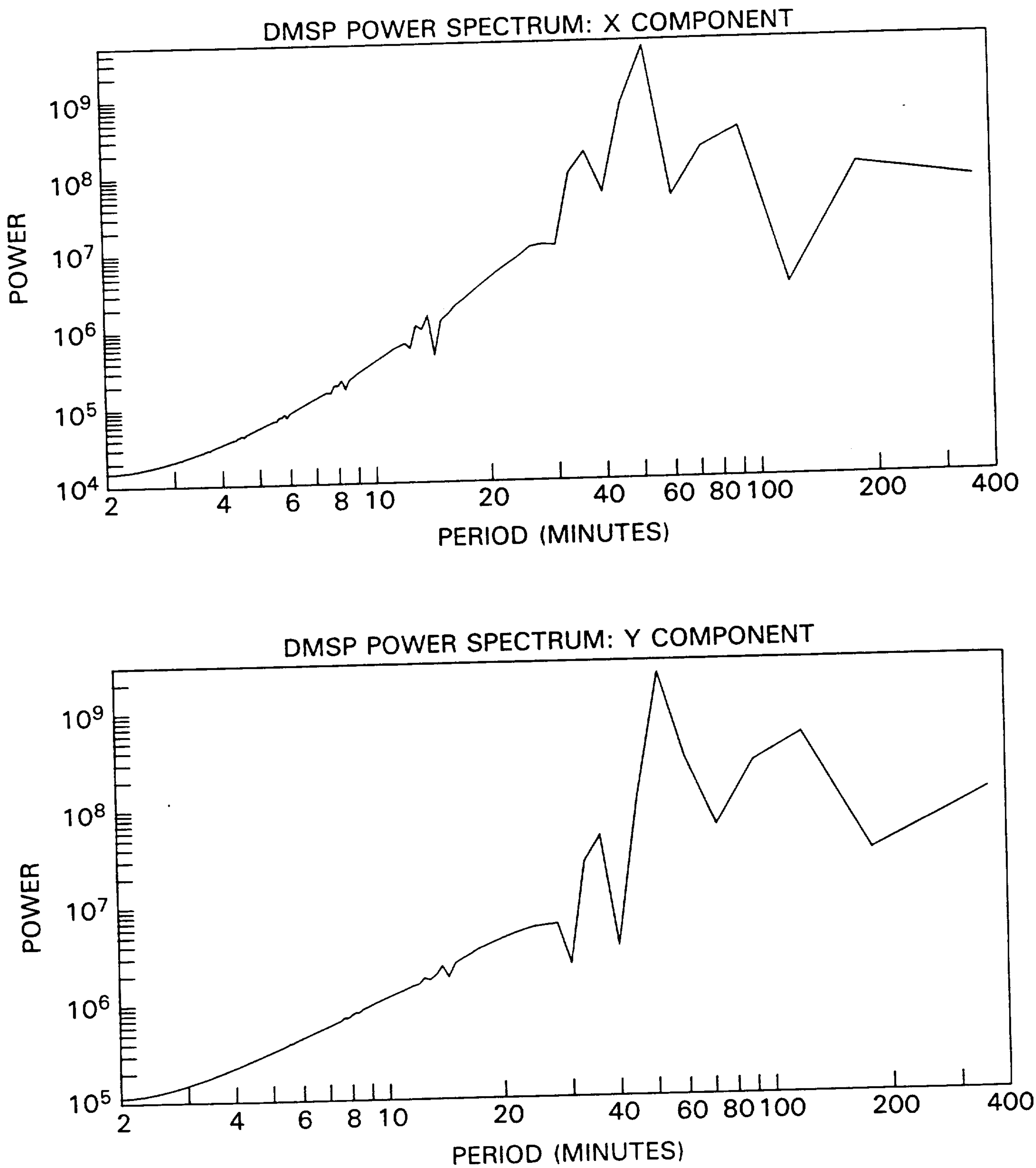
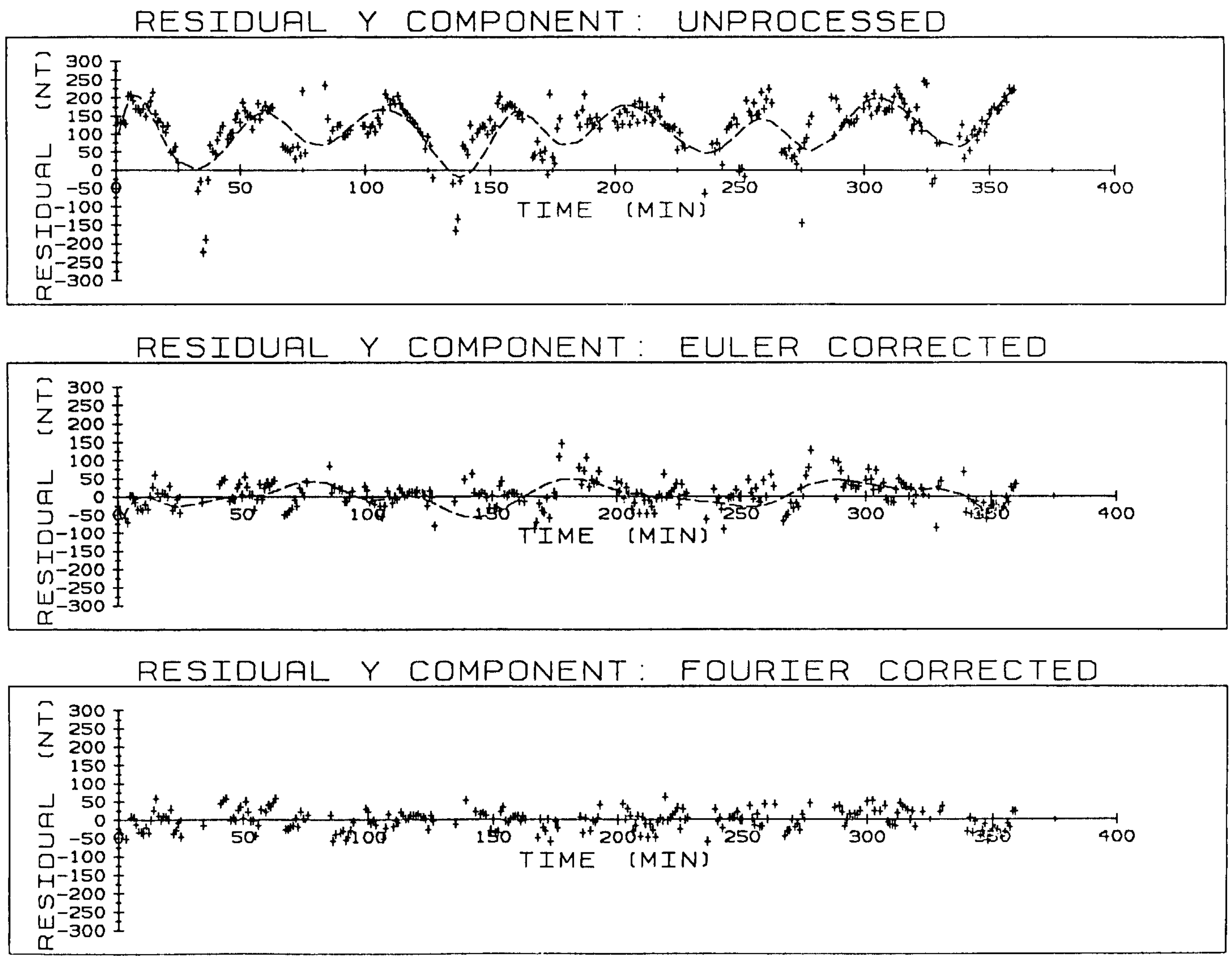

DMSP POWER SPECTRUM: X COMPONENT
POWER
10^9
10^8
10^7
10^6
10^5
10^4
2
4
6
8
10
20
40
60
80
100
200
400
PERIOD (MINUTES)
DMSP POWER SPECTRUM: Y COMPONENT
POWER
10^9
10^8
10^7
10^6
10^5
2
4
6
8
10
20
40
60
80
100
200
400
PERIOD (MINUTES)

FIGURE 2



RESIDUAL Y COMPONENT: UNPROCESSED
RESIDUAL (NT)
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
50
100
150
200
250
300
350
400
TIME (MIN)
RESIDUAL Y COMPONENT: EULER CORRECTED
RESIDUAL (NT)
TIME (MIN)
RESIDUAL Y COMPONENT: FOURIER CORRECTED
RESIDUAL (NT)
TIME (MIN)

FIGURE 3

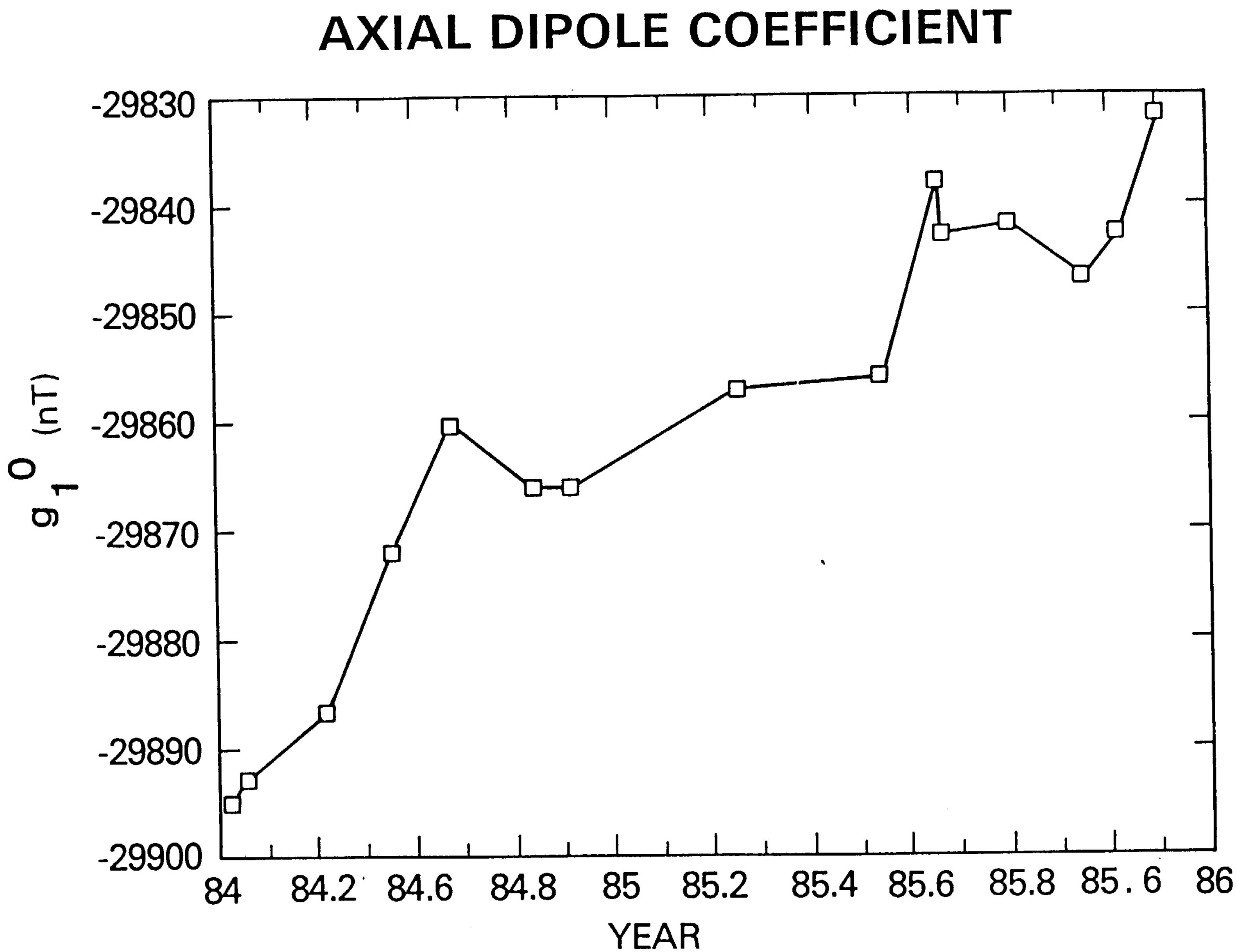

AXIAL DIPOLE COEFFICIENT
-29830
-29840
-29850
-29860
-29870
-29880
-29890
-29900
g 1 0 (nT)
84
84.2
84.6
84.8
85
85.2
85.4
85.6
85.8
85.6
86
YEAR

FIGURE 4a

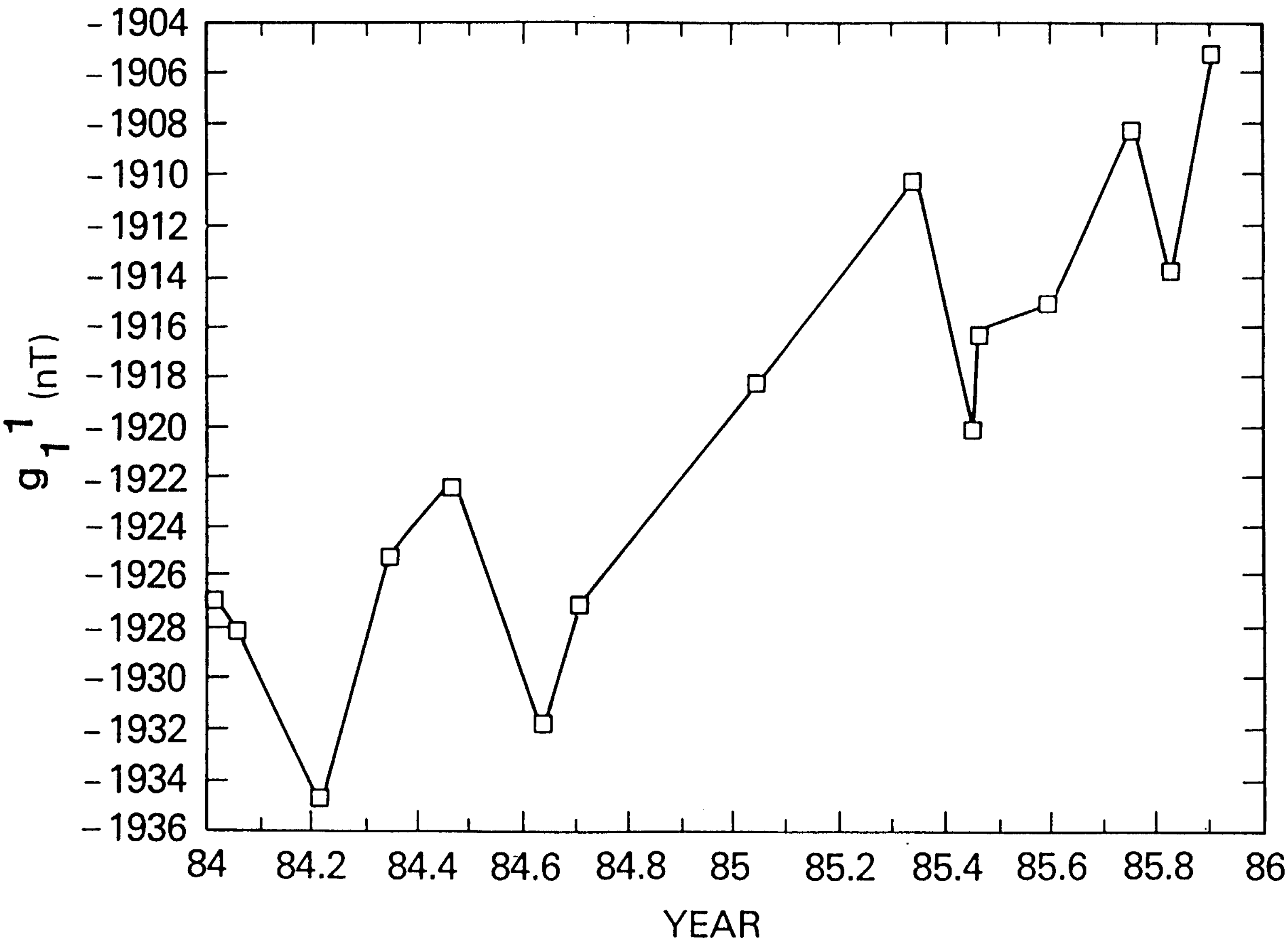

-1904
-1906
-1908
-1910
-1912
-1914
-1916
-1918
-1920
-1922
-1924
-1926
-1928
-1930
-1932
-1934
-1936
g_1^1 (nT)
84
84.2
84.4
84.6
84.8
85
85.2
85.4
85.6
85.8
86
YEAR

FIGURE 4b

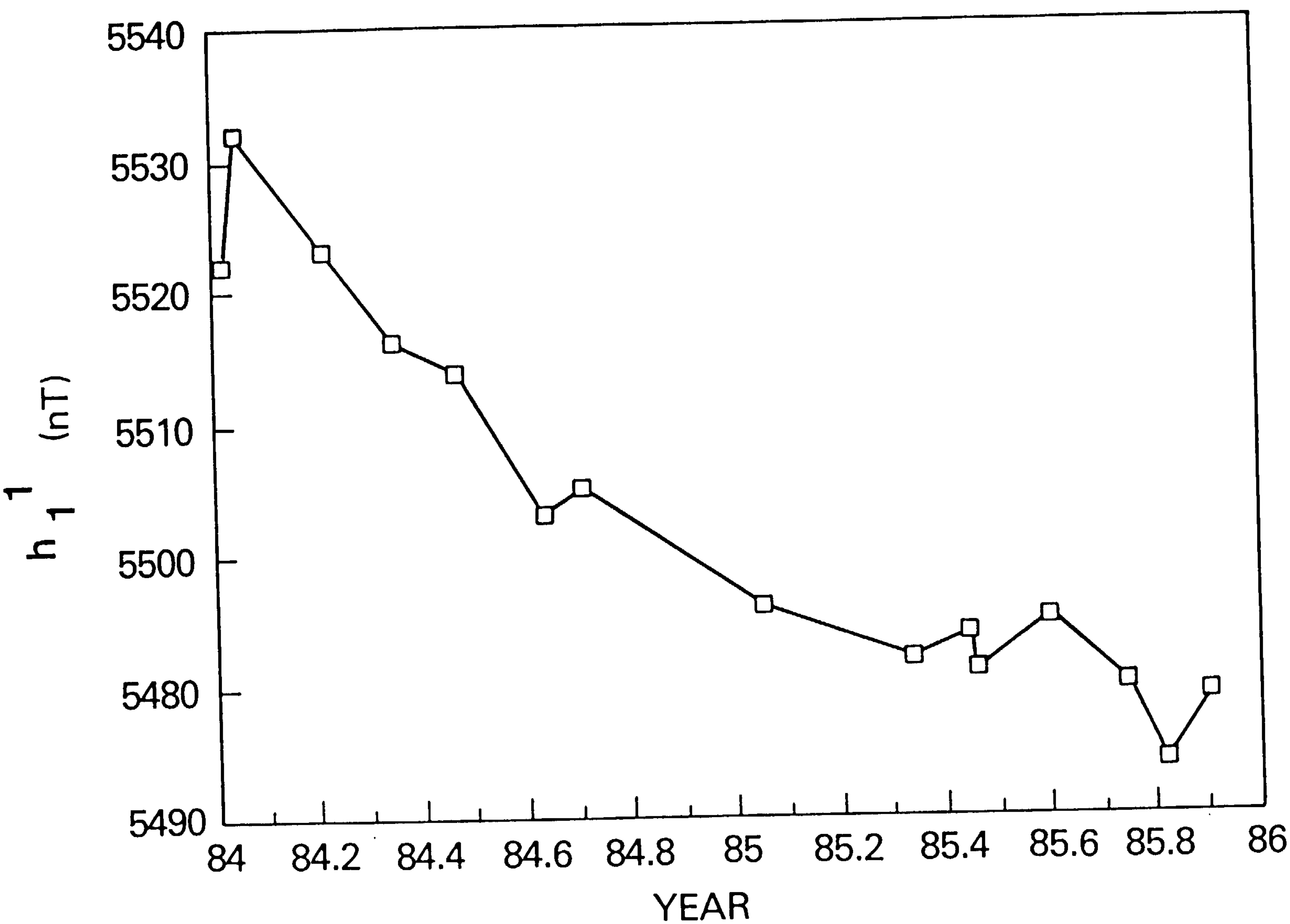

5540
5530
5520
5510
5500
5480
5490
h_1^1 (nT)
84
84.2
84.4
84.6
84.8
85
85.2
85.4
85.6
85.8
86
YEAR

FIGURE 4c

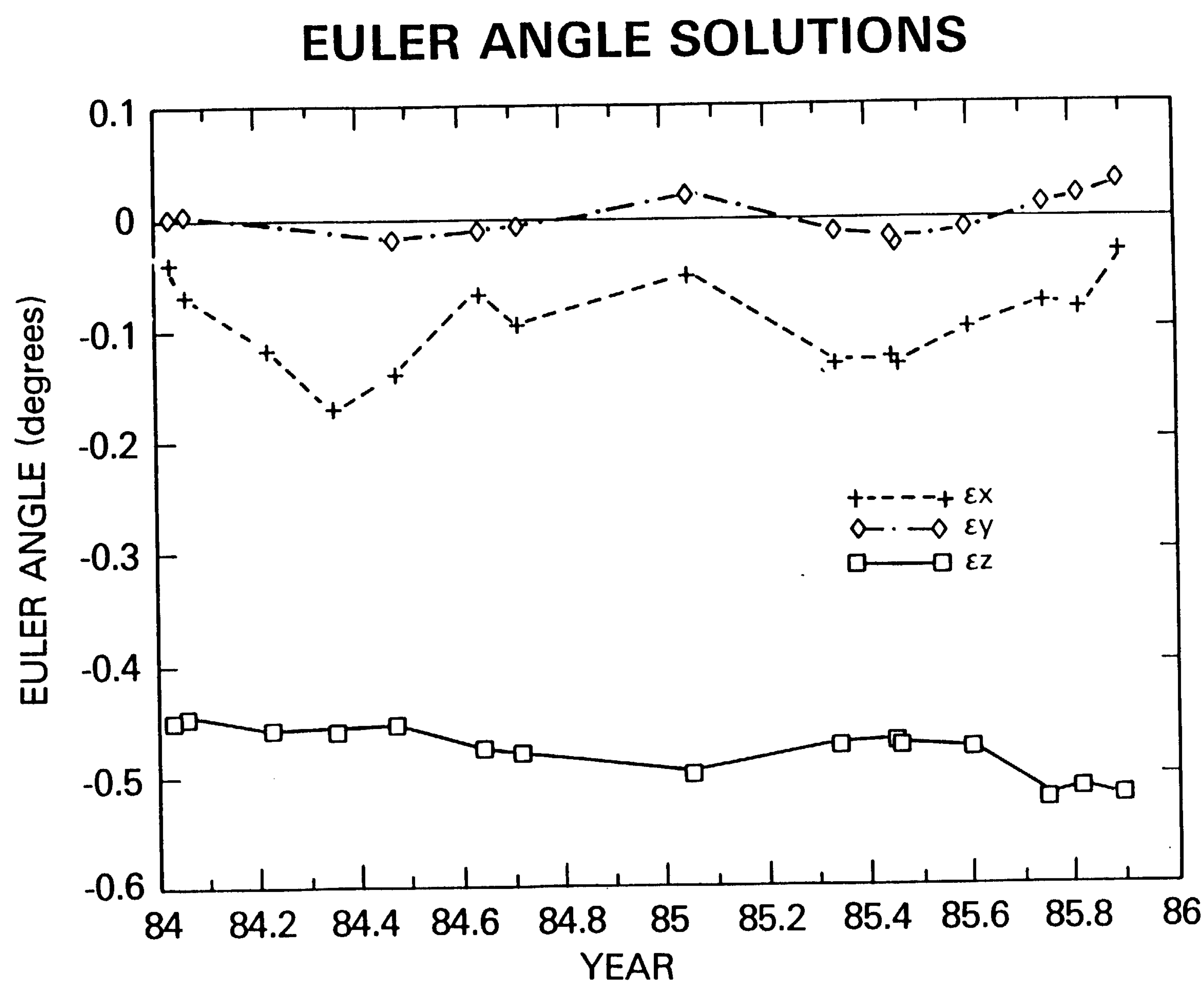

EULER ANGLE SOLUTIONS
EULER ANGLE (degrees)
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
84
84.2
84.4
84.6
84.8
85
85.2
85.4
85.6
85.8
86
YEAR
εx
εy
εz

FIGURE 4d

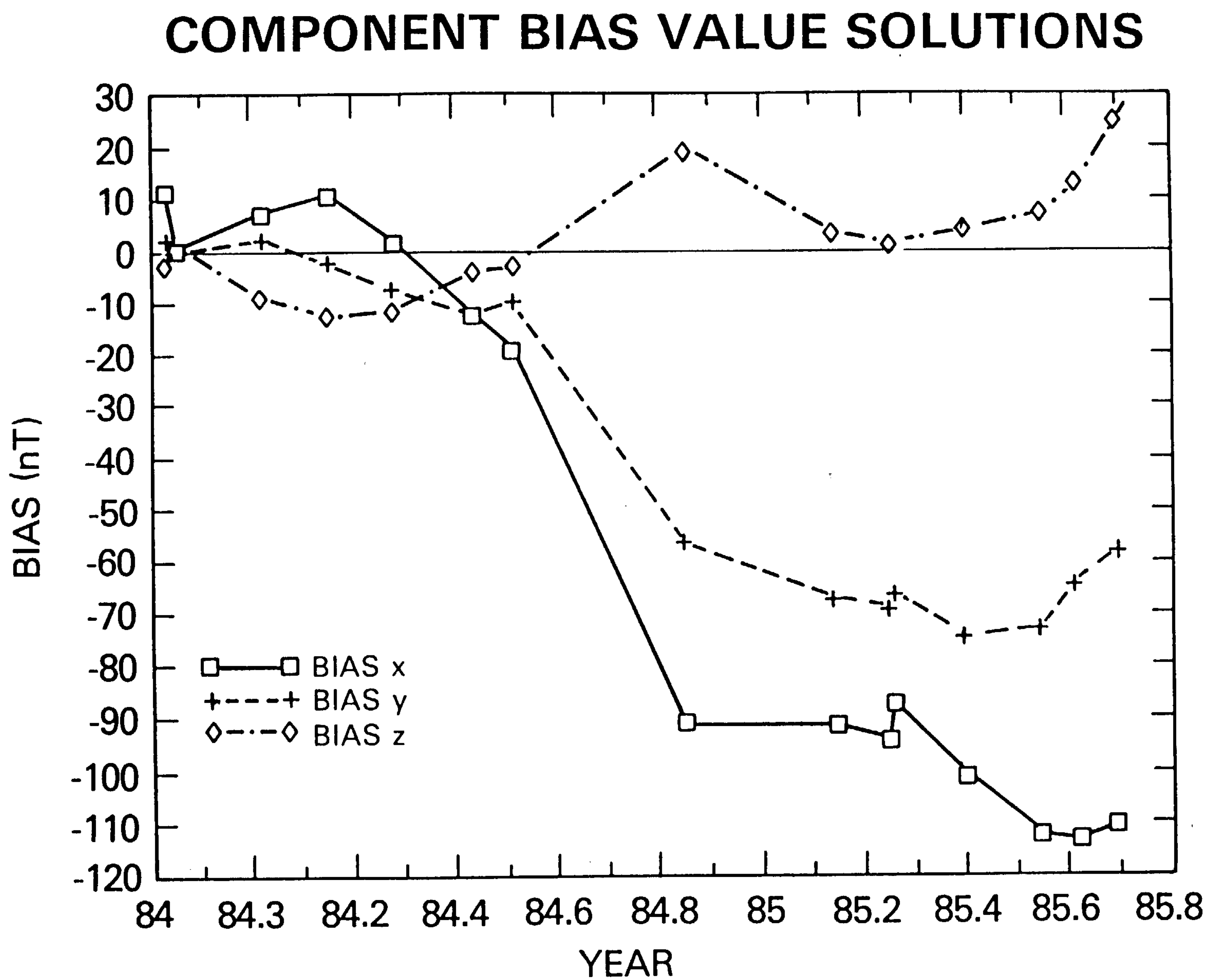

COMPONENT BIAS VALUE SOLUTIONS
BIAS (nT)
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
84
84.3
84.2
84.4
84.6
84.8
85
85.2
85.4
85.6
85.8
YEAR
BIAS x
BIAS y
BIAS z

FIGURE 4e

APPENDIX

This appendix contains listings of the primary programs used in the processing of the DMSP data. Most of these are documented with internal comments.

```
      PROGRAM FILTER
C
C=====================================================================
C
C PROGRAM TO PRE-PROCESS SATELLITE MAGNETIC VECTOR DATA. THE PROGRAM IS
C COMPRISED OF FIVE STEPS, EACH MODULARLY DESIGNED:
C
C STEP 1:
C ======
C
C PERFORMED IN SUBROUTINE STEP1, IT INVOLVES THE READING OF AN ORIGINAL
C SATELLITE MAGNETIC DATA TAPE, AND TRANSFORMING THE RAW MAGNETOMETER
C COUNTS TO MAGNETIC FIELD VALUES IN THE SPACECRAFT COORDINATE SYSTEM.
C
C STEP 2:
C ======
C
C PERFORMED IN SUBROUTINE STEP2, IT INVOLVES THE LOCATION AND PADDING OF
C TIME GAPS IN THE DATA, AND THE DETERMINATION OF THE DIRECTION OF THE
C SPACECRAFT VELOCITY VECTOR AT EACH MEASUREMENT LOCATION.
C
C STEP 3:
C ======
C
C PERFORMED IN SUBROUTINE STEP3, IT INVOLVES THE TRANSFORMATION OF THE
C MAGNETIC FIELD MEASUREMENTS FROM SPACECRAFT TO TOPOCENTRIC COORDINATE
C SYSTEM FROM WHICH RESIDUAL MEASUREMENTS ARE DETERMINED FROM A GIVEN
C FIELD MODEL. DATA LOCATIONS AT WHICH ANY VECTOR RESIDUAL EXCEEDS THE
C SPECIFIED TOLERANCE ARE FLAGGED AS OUTLIERS.
C
C STEP 4:
C ======
C
C PERFORMED IN SUBROUTINE STEP4, IT INVOLVES FITTING A TREND TO THE
C MAGNETIC FIELD RESIDUALS WITH B-SPLINES AND/OR FOURIER WAVEFORMS, WITH
C THE OPTION OF FLAGGING POINTS WHOSE TREND RESIDUALS EXCEED A GIVEN
C TOLERANCE AND THE OPTION OF DETRENDING THE ORIGINAL DATA.
C
C STEP 5:
C ======
C
C PERFORMED IN SUBROUTINE STEP5, IT INVOLVES OUTPUTTING A FINAL MODIFIED
C SATELLITE MAGNETIC DATA TAPE IN THREE BASIC FORMS:
C
C (1) EBCDIC TAPE IN TOPOCENTRIC COORDINATES
C (2) EBCDIC TAPE IN DESIRED SPACECRAFT COORDINATES
C (3) BINARY TAPE IN OLD FIT PROGRAM FORMAT (MAGSAT CONVENTION)
C
C---------------------------------------------------------------------
C
C PROGRAM FILTER MAY RUN IN ONE OF FOUR MODES INDICATED BY THE INPUT
C VARIABLE IMODE:
C
C IMODE = 0:
C =========
C
C PERFORM STEPS 1, 2, 3, 4, AND 5
C
C IMODE = 1:
C =========
```

```
C
C PERFORM STEPS 4, AND 5
C
C IMODE = 2:
C =========
C
C PERFORM STEP 4
C
C IMODE = 3:
C =========
C
C PERFORM STEPS 1, 2, 3, AND 4
C
C-----------------------------------------------------------------
C
C PROGRAM FILTER OPERATION IS GOVERNED BY VARIABLES INPUT THROUGH FIVE
C NAMELIST CATAGORIES:
C
C CONTRL:
C ======
C
C GOVERNS PROGRAM MODE AND EPHEMERIS PROCESSING DETAILS.
C
C IOFILE:
C ======
C
C ESTABLISHES PROGRAM LOGICAL UNITS.
C
C BSPLIN:
C ======
C
C PROVIDES VECTOR MEASUREMENT SIGMAS AND INFORMATION CONCERNING TREND
C FITTING VIA B-SPLINES AND/OR FOURIER WAVEFORMS.
C
C OUTLIM:
C ======
C
C PROVIDES RESIDUAL FIELD TOLERANCE LEVELS, MAGNETIC LATITUDE TOLERANCE
C LEVELS, GEOCENTRIC LATITUDE TOLERANCE LEVEL, GEODETIC LATITUDE ABOVE
C WHICH SPACECRAFT VELOCITY VECTOR DIRECTION IS INDETERMINABLE, AND TIME
C GAP TOLERANCE LEVEL.
C
C FIELDP:
C ======
C
C PROVIDES INFORMATION FOR THE APPLICATION OF THE GIVEN MAGNETIC FIELD
C MODEL TO BE USED AS A BASIS FOR RESIDUAL FIELD MEASUREMENTS.
C
C TRFORM:
C ======
C
C PROVIDES VARIOUS ROTATION ANGLES, SLOPES, AND BIASES USED TO TRANSFORM
C THE RAW MAGNETOMETER COUNTS TO MAGNETIC FIELD VALUES IN THE SPACECRAFT
C COORDINATE SYSTEM.
C
C-----------------------------------------------------------------
C
C PROGRAM FILTER REQUIRES UP TO THREE INPUT DATA SETS LOCATED ON THE
C FOLLOWING LOGICAL UNITS:
C
```

```
C IST1:
C ====
C
C SATELLITE MAGNETIC VECTOR MEASUREMENTS IN RAW MAGNETOMETER COUNTS,
C CURRENTLY IN DMSP SATELLITE FORMAT.
C
C IOCF:
C ====
C
C MAGNETIC FIELD MODEL INFORMATION IN PROGRAM FID FORMAT.
C
C IOBS:
C ====
C
C B-SPLINE KNOT POSITIONS, FOURIER WAVEFORM FREQUENCIES, AND OBSERVATION
C SIGMAS FOR MAGNETIC FIELD VALUES.
C
C-----------------------------------------------------------------------
C
C               ========================================
C               GLOSSARY OF PROGRAM FILTER NAMELIST ITEMS
C               ========================================
C
C     NAMELIST IOFILE -
C     ===============
C
C     IST1   - INPUT UNIT FOR ORIGINAL RAW DATA TAPE(S) IN STEP1.
C
C     IST2   - INPUT UNIT IN STEP2, OUTPUT UNIT IN STEP1, MAGNETIC FIELD
C              IN FIT/MAGSAT COORDINATES.
C
C     IST3   - INPUT UNIT IN STEP3, OUTPUT UNIT IN STEP2, VELOCITY
C              DIRECTIONS AND PADDED TIME-GAPS.
C
C     IST4   - INPUT UNIT IN STEP4, OUTPUT UNIT IN STEP3, MAGNETIC FIELD
C              AND RESIDUALS IN TOPOCENTRIC COORDINATES.
C
C     IOR    - FILTER INPUT UNIT, SAME AS IST4 IN OPERATION MODE 0
C              AND 3.
C
C     IOW    - FILTER OUTPUT UNIT, INPUT UNIT IN STEP5.
C
C     IOF    - OUTPUT UNIT IN STEP5, FORMATTED MAGNETIC FIELD IN FIT/
C              MAGSAT OR TOPOCENTRIC COORDINATES DEPENDING ON IBTBS
C              VALUE.
C
C     IOD    - OUTPUT UNIT IN STEP5, FORMATTED MAGNETIC FIELD IN DESIRED
C              SPACECRAFT COORDINATES.
C
C     IOB    - OUTPUT UNIT IN STEP5, BINARY MAGNETIC FIELD IN PROGRAM
C              FIT FORMAT.
C
C     ISC1   - FILTER SCRATCH UNIT.
C
C     ISC2   - FILTER SCRATCH UNIT.
C
C     ISC3   - SCRATCH UNIT USED IN SUBPROGRAM DPINFO TO STORE VARIOUS
C              DATA PARAMETERS.
C
C     NAMELIST FIELDP -
```

```
C     ===============
C
C     JJ     - FID INPUT POSITION COORDINATES:  (0) GEODETIC
C              (1) GEOCENTRIC.
C
C     MM     - FID EQUITORIAL RADIUS AND RECIPROCAL FLATTENING:
C              (0) DEFAULT AE = 6378.16 KM, FLAT = 298.25 (1) INPUT
C              VALUES.
C
C     NMX    - MAXIMUM DEGREE OF FID MODEL EVALUATION.
C
C     NEXT   - EXTERNAL FIELD MODEL:  (0) DO NOT EVALUATE (1) EVALUATE.
C
C     IOCF   - INPUT UNIT IN FID FOR COMPUTED MAGNETIC FIELD MODEL.
C
C     IDST   - INDUCED FIELD COEFFICIENTS:  (0) DO NOT EVALUATE
C              (1) EVALUATE.
C
C     DST    - DST VALUE.
C
C     LL     - FID FIELD EVALUATION MODE:  (-1) EVALUATE AT OLD TIME
C              (0) EVALUATE (1) READ FIELD MODEL AND EVALUATE.
C
C     NAMELIST BSPLIN -
C     ===============
C
C     H      - ARRAY CONTAINING NUMBER OF INTERNAL KNOTS FOR B-SPLINE
C              FUNCTIONS FITTING X, Y, AND Z COMPONENTS, RESPECTIVELY.
C
C     NN     - ARRAY CONTAINING ORDER OF B-SPLINE FUNCTIONS FITTING X,
C              Y, AND Z COMPONENTS, RESPECTIVELY.
C
C     NT     - ARRAY CONTAINING NUMBER OF FOURIER WAVEFORMS FITTING X,
C              Y, AND Z COMPONENTS, RESPECTIVELY.
C
C     KA     - B-SPLINE INTERNAL KNOT ADJUSTMENT FOR BEST FIT WITH
C              RESPECT TO WEIGHTED RMS:  (0) DO NOT ADJUST  (1) ADJUST
C
C     ITERMX - MAXIMUM NUMBER OF ITERATIONS IN UNIVARIANT SEARCH FOR
C              OPTIMUM B-SPLINE KNOT POSITIONS.
C
C     LGRMAX - MAXIMUM NUMBER OF ITERATIONS IN LAGRANGIAN INTERPOLATIVE
C              SEARCH FOR BEST POSITION OF A PARTICULAR KNOT WITH
C              RESPECT TO WEIGHTED RMS.
C
C     EPS    - KNOT ADJUSTMENT TOLERANCE WITHIN WHICH THE KNOT POSITION
C              IS CONSIDERED TO HAVE CONVERGED.
C
C     KO     - BOOLEAN NUMBER IN WHICH EACH DIGIT GOVERNS THE ADJUSTMENT
C              OF A PARTICULAR INTERNAL KNOT POSITION, WITH LEFT-MOST
C              DIGIT CORRESPONDING TO LEFT-MOST KNOT:  (0) ADJUST
C              (1) DO NOT ADJUST.
C
C     IOBS   - INPUT UNIT CONTAINING B-SPLINE KNOT POSITIONS, FOURIER
C              WAVEFORM FREQUENCIES, AND SIGMAS FOR OBSERVED MAGNETIC
C              FIELD VALUES.
C
C     NAMELIST TRFORM -
C     ===============
C
```

```
C     EU     - FIT EULER ANGLES (DEGREES).
C
C     QI     - GSFC NOMINAL BIAS CORRECTIONS IN ORIGINAL SATELLITE
C              COORDINATES (NT).
C
C     QF     - FIT MAGNETOMETER BIAS ADJUSTMENTS (NT).
C
C     CF     - FIT CALIBRATION SLOPE ADJUSTMENT MATRIX.
C
C     CA     - CALIBRATION MATRIX IN ORIGINAL SATELLITE COORDINATES.
C
C     RF     - ROTATION MATRIX FROM ORIGINAL SATELLITE TO FIT/MAGSAT
C              COORDINATES.
C
C     RC     - ROTATION MATRIX FROM FIT/MAGSAT TO DESIRED SATELLITE
C              COORDINATES.
C
C     NAMELIST CONTRL -
C     ===============
C
C     IMODE  - PROGRAM OPERATION MODE:  (0) RAW-TO-FINAL FIT TAPE TOTAL
C              PROCESSING  (1) FILTER-TO-FINAL FIT TAPE PROCESSING
C              (2) FILTER PROCESSING ONLY  (3) RAW-TO-FILTER TAPE
C              PROCESSING.
C
C     IFORM  - ORIGINAL RAW DATA TAPE(S) FORMAT:  (0) EARLY FORMAT --
C              2 SAMPLES/SECOND  (1) LATTER FORMAT -- 20 SAMPLES/SECOND
C
C     NDATAR - NUMBER OF DATA RECORDS PROCESSED AFTER EPHEMERIS RECORD.
C
C     INPUTF - NUMBER OF INPUT FILES TO BE PROCESSED.
C
C     IARC   - ARC PROCESSING LENGTH:  (0) ENTIRE ARC  (1) ARC SEGMENT
C              BETWEEN BEGINNING AND ENDING TIMES ONLY.
C
C     IYRBEG - BEGINNING ARC TIME YEAR SINCE 1900.
C
C     IDYBEG - BEGINNING ARC TIME DAY NUMBER.
C
C     ISCBEG - BEGINNING ARC TIME SECONDS.
C
C     IYREND - ENDING ARC TIME YEAR SINCE 1900.
C
C     IDYEND - ENDING ARC TIME DAY NUMBER.
C
C     ISCEND - ENDING ARC TIME SECONDS.
C
C     ORBINC - SATELLITE ORBIT INCLINATION ANGLE (DEGREES).
C
C     ERAD   - MEAN EARTH RADIUS (KM).
C
C     IEPDAY - FILTER REFERENCE DAY NUMBER.
C
C     INCREM - FILTER WINDOW LENGTH (SECONDS).
C
C     INTRVL - FILTER WINDOW NUMBER FROM BEGINNING OF REFERENCE DAY.
C
C     IMETH  - FILTER METHOD:  (0) DETREND  (1) DETREND AND FLAG
C              OUTLIERS  (2) FLAG OUTLIERS  (3) NO MODIFICATION.
C
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C     ISPEC  - FFT SPECTRAL ANALYSIS:  (0) NO ANALYSIS  (1) ZERO-MEAN
C              ANALYSIS  (2) DIRECT ANALYSIS.
C
C     NEXTIN - NUMBER OF SUCCESSIVE FILTER WINDOWS TO BE PROCESSED
C              DURING THIS RUN BEGINNING WITH WINDOW NUMBER "INTRVL".
C
C     IBTBS  - FINAL TAPE OUTPUT COORDINATES:  (0) FORMATTED TOPOCENTRIC
C              (1) FORMATTED/BINARY FIT/MAGSAT  (2) SAME AS 1, PLUS
C              FORMATTED DESIRED SATELLITE.
C
C     SIGMLT - OUTLIER MULTIPLICATION FACTOR FOR TREND RESIDUAL SIGMA.
C
C     NFLAGK - DATA QUALITY FLAG RETENTION CODE FOR FILTER:  EACH DIGIT
C              INDICATES FLAG TO BE RETAINED FOR TREND FITTING.
C
C     IOWIOF - UNIT IOW INTERVALS FOR FINAL PROCESSING:  (0) INTRVL ONLY
C              (1) INTRVL AND PRECEEDING  (2) ALL.
C
C     IOF1ST - OUTPUT DATA FLAG FOR UNITS IOF AND IOB:  (0) DATA WILL BE
C              APPENDED  (1) DATA WILL BE FIRST.
C
C     IOD1ST - OUTPUT DATA FLAG FOR UNIT IOD:  (0) DATA WILL BE APPENDED
C              (1) DATA WILL BE FIRST.
C
C     IOW1ST - OUTPUT DATA FLAG FOR UNIT IOW:  (0) DATA WILL BE APPENDED
C              (1) DATA WILL BE FIRST.
C
C     NAMELIST OUTLIM -
C     ===============
C
C     DXOL   - MAGNITUDE TOLERANCE FOR RESIDUAL TOPOCENTRIC X
C              COMPONENT (NT).
C
C     DYOL   - MAGNITUDE TOLERANCE FOR RESIDUAL TOPOCENTRIC Y
C              COMPONENT (NT).
C
C     DZOL   - MAGNITUDE TOLERANCE FOR RESIDUAL TOPOCENTRIC Z
C              COMPONENT (NT).
C
C     DBOL   - MAGNITUDE TOLERANCE FOR RESIDUAL TOPOCENTRIC B
C              COMPONENT (NT).
C
C     XWINDO - MAGNETIC LATITUDE TOLERANCE FOR FIT/MAGSAT X COMPONENT.
C
C     YWINDO - MAGNETIC LATITUDE TOLERANCE FOR FIT/MAGSAT Y COMPONENT.
C
C     ZWINDO - MAGNETIC LATITUDE TOLERANCE FOR FIT/MAGSAT Z COMPONENT.
C
C     BWINDO - MAGNETIC LATITUDE TOLERANCE FOR FIT/MAGSAT B COMPONENT.
C
C     ABVLAT - FILTER GEOCENTRIC LATITUDE TOLERANCE FOR ALL COMPONENTS.
C
C     TRNLAT - GEODETIC LATITUDE ABOVE WHICH SATELLITE VELOCITY
C              DIRECTION IS INDETERMINABLE.
C
C     ITMGAP - TIME-GAP TOLERANCE INCREMENT FOR DATA (SECONDS).
C
C=====================================================================
C
      CHARACTER*80 TITLE
```

```
      INTEGER H(3)
      DIMENSION EU(3),CA(3,3),QI(3),QF(3),CF(3),RF(3,3),RC(3,3),NN(3)
      DIMENSION NT(3),KA(3),ITERMX(3),LGRMAX(3),EPS(3),KO(3),SIG(3,500)
      DIMENSION EKNOTS(3,500),FREQ(3,500)
      NAMELIST /IOFILE/ IST1,IST2,IST3,IST4,IOR,IOW,IOF,IOD,IOB,ISC1,
     *                  ISC2,ISC3
      NAMELIST /FIELDP/ JJ,MM,NMX,NEXT,IOCF,IDST,DST,LL
      NAMELIST /BSPLIN/ H,NN,NT,KA,ITERMX,LGRMAX,EPS,KO,IOBS
      NAMELIST /TRFORM/ EU,QI,QF,CF,CA,RF,RC
      NAMELIST /CONTRL/ IMODE,IFORM,NDATAR,INPUTF,IARC,IYRBEG,IDYBEG,
     *                  ISCBEG,IYREND,IDYEND,ISCEND,ORBINC,ERAD,IEPDAY,
     *                  INCREM,INTRVL,IMETH,ISPEC,NEXTIN,IBTBS,SIGMLT,
     *                  NFLAGK,IOWIOF,IOF1ST,IOD1ST,IOW1ST
      NAMELIST /OUTLIM/ DXOL,DYOL,DZOL,DBOL,XWINDO,YWINDO,ZWINDO,BWINDO,
     *                  ABVLAT,TRNLAT,ITMGAP
      COMMON /STFILE/ IST1,IST2,IST3,IST4
      COMMON /MDFILE/ IOR,IOW,IOF,IOD,IOB,IOF1ST,IOD1ST,IOW1ST,IOWIOF
      COMMON /SCFILE/ ISC1,ISC2,ISC3
      COMMON /ARCLIM/ IARC,IYRBEG,IDYBEG,ISCBEG,IYREND,IDYEND,ISCEND,
     *                IFORM,NDATAR,INPUTF
      COMMON /IFIELD/ JJ,MM,NMX,NEXT,IOCF,IDST,DST,LL
      COMMON /SPLINE/ H,NN,NT,KA,ITERMX,LGRMAX,EPS,KO,SIG,EKNOTS,FREQ
      COMMON /COTRAN/ EU,CA,QI,QF,CF,RF,RC
      COMMON /EPHEMS/ ORBINC,ERAD,IEPDAY,INCREM,INTRVL
      COMMON /FILTOP/ IMETH,ISPEC,IBTBS,SIGMLT,NFLAGK
      COMMON /LIMITS/ DXOL,DYOL,DZOL,DBOL,XWINDO,YWINDO,ZWINDO,BWINDO,
     *                ABVLAT,TRNLAT,ITMGAP
      DATA IOBS /22/
      READ(5,100) TITLE
  100 FORMAT(A80)
      READ(5,CONTRL)
      READ(5,IOFILE)
      READ(5,BSPLIN)
      READ(5,OUTLIM)
      IF((IMODE.EQ.0).OR.(IMODE.EQ.3)) READ(5,FIELDP)
      IF(IMODE.NE.2) READ(5,TRFORM)
      WRITE(6,101)
  101 FORMAT(1X,'*******************************************************
     ********************************************************'/1X,'****
     ** G S F C   S A T E L L I T E   M A G N E T I C   D A T A   P R E -
     ** P R O C E S S I N G   P R O G R A M ****'/1X,'*******************
     *******************************************************************
     ***************************'//)
      WRITE(6,102) IMODE
  102 FORMAT(1X,'PROGRAM OPERATION MODE -->  IMODE = ',I1,' ..... (0) RA
     *W-TO-FINAL FIT TAPE TOTAL PROCESSING'/45X,'(1) FILTER-TO-FINAL FIT
     * TAPE PROCESSING'/45X,'(2) FILTER PROCESSING ONLY'/45X,'(3) RAW-TO
     *-FILTER TAPE PROCESSING'//)
      WRITE(6,103) IFORM
  103 FORMAT(1X,'TAPE FORMAT MODE -->  IFORM = ',I1,' ..... (0) EARLY FO
     *RMAT  --  2 SAMPLES/SECOND'/39X,'(1) LATTER FORMAT -- 20 SAMPLES/S
     *ECOND'//)
      WRITE(6,104) TITLE
  104 FORMAT(1X,'TITLE --> ',A80//)
      WRITE(6,105) ORBINC,ERAD,IEPDAY,INCREM,INTRVL,IMETH,ISPEC,NEXTIN,
     *IBTBS,SIGMLT,NDATAR,INPUTF
  105 FORMAT(1X,'<CONTROL AND EPHEMERIS INFORMATION>'//1X,'ORBINC = ',F7
     *.2,' -->  SATELLITE ORBIT INCLINATION ANGLE (DEGREES)'/1X,'ERAD
     *= ',F7.2,' -->  MEAN EARTH RADIUS (KM)'/1X,'IEPDAY = ',I7,' -->  F
     *ILTER REFERENCE DAY NUMBER'/1X,'INCREM = ',I7,' -->  FILTER WINDOW
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     * LENGTH (SECONDS)'/1X,'INTRVL = ',I7,' -->  FILTER WINDOW NUMBER F
     *ROM BEGINNING OF REFERENCE DAY'/1X,'IMETH  = ',I7,' -->  FILTER ME
     *THOD:  (0) DETREND  (1) DETREND AND FLAG OUTLIERS  (2) FLAG OUTLIE
     *RS  (3) NO MODIFICATION'/1X,'ISPEC  = ',I7,' -->  FFT SPECTRAL ANA
     *LYSIS:  (0) NO ANALYSIS  (1) ZERO-MEAN ANALYSIS  (2) DIRECT ANALYS
     *IS'/1X,'NEXTIN = ',I7,' -->  NUMBER OF SUCCESSIVE FILTER WINDOWS T
     *O BE PROCESSED DURING THIS RUN BEGINNING WITH WINDOW NUMBER INTRVL
     *'/1X,'IBTBS  = ',I7,' -->  FINAL TAPE OUTPUT COORDINATES:  (0) FMT
     * TOPOCENTRIC  (1) FMT/BIN FIT/MAGSAT  (2) SAME AS 1, PLUS FMT DESI
     *RED'/1X,'SIGMLT = ',F7.3,' -->  OUTLIER MULTIPLICATION FACTOR FOR
     *TREND RESIDUAL SIGMA'/1X,'NDATAR = ',I7,' -->  NUMBER OF DATA RECO
     *RDS PROCESSED AFTER EPHEMERIS RECORD'/1X,'INPUTF = ',I7,' -->  NUM
     *BER OF INPUT FILES TO BE PROCESSED')
      WRITE(6,106) NFLAGK,IOF1ST,IOD1ST,IOW1ST,IOWIOF
  106 FORMAT(1X,'NFLAGK = ',I7,' -->  DATA QUALITY FLAG RETENTION CODE F
     *OR FILTER:  EACH DIGIT INDICATES FLAG TO BE RETAINED FOR TREND FIT
     *TING'/1X,'IOF1ST = ',I7,' -->  OUTPUT DATA FLAG FOR UNITS IOF AND
     *IOB:  (0) DATA WILL BE APPENDED  (1) DATA WILL BE FIRST'/1X,'IOD1S
     *T = ',I7,' -->  OUTPUT DATA FLAG FOR UNIT IOD:  (0) DATA WILL BE A
     *PPENDED  (1) DATA WILL BE FIRST'/1X,'IOW1ST = ',I7,' -->  OUTPUT D
     *ATA FLAG FOR UNIT IOW:  (0) DATA WILL BE APPENDED  (1) DATA WILL B
     *E FIRST'/1X,'IOWIOF = ',I7,' -->  UNIT IOW INTERVALS FOR FINAL PRO
     *CESSING:  (0) INTRVL ONLY  (1) INTRVL AND PRECEEDING  (2) ALL'//)
      WRITE(6,107) IARC
  107 FORMAT(1X,'<SATELLITE ARC PROCESSING INFORMATION>',//1X,'IARC   =
     *',I5,' -->  ARC PROCESSING LENGTH:  (0) ENTIRE ARC  (1) ARC SEGMEN
     *T BETWEEN BEGINNING AND ENDING TIMES ONLY')
      IF(IARC.EQ.0) WRITE(6,108)
  108 FORMAT(/)
      IF(IARC.EQ.1) WRITE(6,109) IYRBEG,IDYBEG,ISCBEG,IYREND,IDYEND,
     *ISCEND
  109 FORMAT(1X,'IYRBEG = ',I5,' -->  BEGINNING TIME YEAR SINCE 1900'/1X
     *,'IDYBEG = ',I5,' -->  BEGINNING TIME DAY NUMBER'/1X,'ISCBEG = ',I
     *5,' -->  BEGINNING TIME SECONDS'/1X,'IYREND = ',I5,' -->  ENDING T
     *IME YEAR SINCE 1900'/1X,'IDYEND = ',I5,' -->  ENDING TIME DAY NUMB
     *ER'/1X,'ISCEND = ',I5,' -->  ENDING TIME SECONDS'//)
      WRITE(6,110) IST1,IST2,IST3,IST4,IOR,IOW,IOF,IOD,IOB,ISC1,ISC2,
     *ISC3
  110 FORMAT(1X,'<INPUT/OUTPUT FILE INFORMATION>'//1X,'IST1 = ',I2,' -->
     *  INPUT UNIT FOR ORIGINAL RAW DATA TAPE(S) IN STEP1'/1X,'IST2 = ',
     *I2,' -->  INPUT UNIT IN STEP2, OUTPUT UNIT IN STEP1, MAGNETIC FIEL
     *D IN FIT/MAGSAT COORDINATES'/1X,'IST3 = ',I2,' -->  INPUT UNIT IN
     *STEP3, OUTPUT UNIT IN STEP2, VELOCITY DIRECTIONS AND PADDED TIME-G
     *APS'/1X,'IST4 = ',I2,' -->  INPUT UNIT IN STEP4, OUTPUT UNIT IN ST
     *EP3, MAGNETIC FIELD AND RESIDUALS IN TOPOCENTRIC COORDINATES'/1X,'
     *IOR  = ',I2,' -->  FILTER INPUT UNIT, SAME AS IST4 IN OPERATION MO
     *DE 0 AND 3'/1X,'IOW  = ',I2,' -->  FILTER OUTPUT UNIT, INPUT UNIT
     *IN STEP5'/1X,'IOF  = ',I2,' -->  OUTPUT UNIT IN STEP5, FORMATTED M
     *AGNETIC FIELD IN FIT/MAGSAT OR TOPOCENTRIC COORDINATES DEPENDING O
     *N IBTBS VALUE'/1X,'IOD  = ',I2,' -->  OUTPUT UNIT IN STEP5, FORMAT
     *TED MAGNETIC FIELD IN DESIRED SPACECRAFT COORDINATES'/1X,'IOB  = '
     *,I2,' -->  OUTPUT UNIT IN STEP5, BINARY MAGNETIC FIELD IN PROGRAM
     *FIT FORMAT'/1X,'ISC1 = ',I2,' -->  FILTER SCRATCH UNIT'/1X,'ISC2 =
     * ',I2,' -->  FILTER SCRATCH UNIT'/1X,'ISC3 = ',I2,' -->  SCRATCH U
     *NIT USED IN SUBPROGRAM DPINFO TO STORE VARIOUS DATA PARAMETERS'//)
      WRITE(6,111) IOBS
  111 FORMAT(1X,'<TREND-FIT INPUT FILE NUMBER>'//1X,'IOBS = ',I2,' -->
     *INPUT UNIT IN FILTER, CONTAINS KNOTS, A PRIORI FREQUENCIES, AND OB
     *SERVATION SIGMAS FOR EACH FIELD COMPONENT'//)
      WRITE(6,112) DXOL,DYOL,DZOL,DBOL,XWINDO,YWINDO,ZWINDO,BWINDO,
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     *ABVLAT,TRNLAT,ITMGAP
  112 FORMAT(1X,'<OUTLIER LIMIT INFORMATION>'//1X,'DXOL    = ',F8.2,' -->
     *  MAGNITUDE TOLERANCE FOR RESIDUAL TOPOCENTRIC X COMPONENT (NT)'/1
     *X,'DYOL    = ',F8.2,' -->  MAGNITUDE TOLERANCE FOR RESIDUAL TOPOCEN
     *TRIC Y COMPONENT (NT)'/1X,'DZOL    = ',F8.2,' -->  MAGNITUDE TOLERA
     *NCE FOR RESIDUAL TOPOCENTRIC Z COMPONENT (NT)'/1X,'DBOL    = ',F8.2
     *,' -->  MAGNITUDE TOLERANCE FOR RESIDUAL TOPOCENTRIC B COMPONENT (
     *NT)'/1X,'XWINDO = ',F8.2,' -->  MAGNETIC LATITUDE TOLERANCE FOR FI
     *T/MAGSAT X COMPONENT'/1X,'YWINDO = ',F8.2,' -->  MAGNETIC LATITUDE
     * TOLERANCE FOR FIT/MAGSAT Y COMPONENT'/1X,'ZWINDO = ',F8.2,' -->
     *MAGNETIC LATITUDE TOLERANCE FOR FIT/MAGSAT Z COMPONENT'/1X,'BWINDO
     * = ',F8.2,' -->  MAGNETIC LATITUDE TOLERANCE FOR FIT/MAGSAT B COMP
     *ONENT'/1X,'ABVLAT = ',F8.2,' -->  FILTER GEOCENTRIC LATITUDE TOLER
     *ANCE FOR ALL COMPONENTS'/1X,'TRNLAT = ',F8.2,' -->  GEODETIC LATIT
     *UDE ABOVE WHICH SATELLITE VELOCITY DIRECTION IS INDETERMINABLE'/1X
     *,'ITMGAP = ',I8,' -->  TIME-GAP TOLERANCE INCREMENT FOR DATA (SECO
     *NDS)'//)
      IF((IMODE.EQ.0).OR.(IMODE.EQ.3)) WRITE(6,113) JJ,MM,NMX,NEXT,IOCF,
     *IDST,DST,LL
  113 FORMAT(1X,'<INPUT MAGNETIC FIELD PARAMETERS>'//1X,'JJ     = ',I7,' -
     *->  FID INPUT POSITION COORDINATES:  (0) GEODETIC  (1) GEOCENTRIC'
     */1X,'MM     = ',I7,' -->  FID EQU. RADIUS AND RCP. FLATTENING:  (0)
     *DEFAULT AE = 6378.16 KM, FLAT = 298.25  (1) INPUT VALUES'/1X,'NMX
     * = ',I7,' -->  MAXIMUM DEGREE OF FID MODEL EVALUATION'/1X,'NEXT =
     *',I7,' -->  EXTERNAL FIELD MODEL:  (0) DO NOT EVALUATE  (1) EVALUA
     *TE'/1X,'IOCF = ',I7,' -->  INPUT UNIT IN FID FOR COMPUTED MAGNETIC
     * FIELD MODEL'/1X,'IDST = ',I7,' -->  INDUCED FIELD COEFFICIENTS:
     *(0) DO NOT EVALUATE  (1) EVALUATE'/1X,'DST   = ',F7.2,' -->  DST VA
     *LUE'/1X,'LL     = ',I7,' -->  FID FIELD EVALUATION MODE:  (-1) EVALU
     *ATE AT OLD TIME  (0) EVALUATE  (1) READ FIELD MODEL AND EVALUATE'/
     */)
      IF(IMODE.NE.2) WRITE(6,114) (EU(IK),QI(IK),QF(IK),CF(IK),IK=1,3),
     *((CA(IK,IJ),IJ=1,3),(RF(IK,IL),IL=1,3),(RC(IK,IM),IM=1,3),IK=1,3)
  114 FORMAT(1X,'<TRANSFORMATION INFORMATION>'//1X,'EU -->  FIT EULER AN
     *GLES (DEGREES)'/1X,'QI -->  GSFC NOMINAL BIAS CORRECTIONS IN ORIGI
     *NAL SATELLITE COORDINATES (NT)'/1X,'QF -->  FIT MAGNETOMETER BIAS
     *ADJUSTMENTS (NT)'/1X,'CF -->  FIT CALIBRATION SLOPE ADJUSTMENT MAT
     *RIX'/1X,'CA -->  CALIBRATION MATRIX IN ORIGINAL SATELLITE COORDINA
     *TES'/1X,'RF -->  ROTATION MATRIX FROM ORIGINAL SATELLITE TO FIT/MA
     *GSAT COORDINATES'/1X,'RC -->  ROTATION MATRIX FROM FIT/MAGSAT TO D
     *ESIRED SATELLITE COORDINATES'///1X,'EU = ',F12.5,'  QI = ',F12.5,'
     *  QF = ',F12.5,'  CF = ',F12.5/2(6X,F12.5,3(7X,F12.5)/)/1X,'CA = '
     *,3(F12.5),'  RF = ',3(F12.5),'  RC = ',3(F12.5)/2(6X,3(F12.5),2(7X
     *,3(F12.5))/)/)
      NBD=0
   10 NBD=NBD+1
      READ(IOBS,115,END=20) (EKNOTS(IK,NBD),FREQ(IK,NBD),SIG(IK,NBD),
     *IK=1,3)
  115 FORMAT(3(F7.2,F7.4,F7.3))
      GO TO 10
   20 IF((IMODE.EQ.1).OR.(IMODE.EQ.2)) GO TO 30
      CALL STEP1
      CALL STEP2
      CALL STEP3
   30 DO 40 INTADD=1,NEXTIN
      CALL STEP4(*60,*50)
   60 IF((IMODE.EQ.2).OR.(IMODE.EQ.3)) GO TO 50
      CALL STEP5
      IOF1ST=0
      IOD1ST=0
```

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   50 IOW1ST=0
   40 INTRVL=INTRVL+1
      STOP
      END
      BLOCK DATA
      INTEGER H(3)
      DIMENSION EU(3),CA(3,3),QI(3),QF(3),CF(3),RF(3,3),RC(3,3),NN(3)
      DIMENSION NT(3),KA(3),ITERMX(3),LGRMAX(3),EPS(3),KO(3),SIG(3,500)
      DIMENSION EKNOTS(3,500),FREQ(3,500)
      COMMON /STFILE/ IST1,IST2,IST3,IST4
      COMMON /MDFILE/ IOR,IOW,IOF,IOD,IOB,IOF1ST,IOD1ST,IOW1ST,IOWIOF
      COMMON /SCFILE/ ISC1,ISC2,ISC3
      COMMON /ARCLIM/ IARC,IYRBEG,IDYBEG,ISCBEG,IYREND,IDYEND,ISCEND,
     *                IFORM,NDATAR,INPUTF
      COMMON /IFIELD/ JJ,MM,NMX,NEXT,IOCF,IDST,DST,LL
      COMMON /SPLINE/ H,NN,NT,KA,ITERMX,LGRMAX,EPS,KO,SIG,EKNOTS,FREQ
      COMMON /COTRAN/ EU,CA,QI,QF,CF,RF,RC
      COMMON /EPHEMS/ ORBINC,ERAD,IEPDAY,INCREM,INTRVL
      COMMON /FILTOP/ IMETH,ISPEC,IBTBS,SIGMLT,NFLAGK
      COMMON /LIMITS/ DXOL,DYOL,DZOL,DBOL,XWINDO,YWINDO,ZWINDO,BWINDO,
     *                ABVLAT,TRNLAT,ITMGAP
      DATA IST1,IST2,IST3,IST4,IOR,IOW,IOF,IOD,IOB,ISC1,ISC2,ISC3
     *     /10,11,12,13,13,14,15,16,17,18,19,20/
      DATA IARC,IYRBEG,IDYBEG,ISCBEG,IYREND,IDYEND,ISCEND,IFORM,NDATAR,
     *     INPUTF,IOF1ST,IOD1ST,IOW1ST,IOWIOF /8*0,5*1,0/
      DATA JJ,MM,NMX,NEXT,IOCF,IDST,DST,LL /1,0,14,0,21,0,0.0,1/
      DATA H,NN,NT,KA,ITERMX,LGRMAX,EPS,KO,SIG,EKNOTS,FREQ /3*0,3*4,6*0,
     *     3*20,3*10,3*0.01,3*0,4500*0.0/
      DATA EU,QI,QF,CF,CA,RF,RC /9*0.0,4*1.0,3*0.0,1.0,3*0.0,2*1.0,
     *     3*0.0,1.0,3*0.0,2*1.0,3*0.0,1.0,3*0.0,1.0/
      DATA ERAD,IMETH,ISPEC,IBTBS,SIGMLT,NFLAGK /6371.2,3,0,1,2.0,0/
      DATA DXOL,DYOL,DZOL,DBOL,XWINDO,YWINDO,ZWINDO,BWINDO,ABVLAT,
     *     TRNLAT,ITMGAP /2*10000.0,2000.0,10000.0,50.0,90.0,2*50.0,
     *     75.0,80.0,60/
      END
      SUBROUTINE STEP1
C
C SUBROUTINE TO READ ORIGINAL SATELLITE MAGNETIC DATA TAPE AND TRANSFORM
C RAW MAGNETOMETER COUNTS TO MAGNETIC FIELD VALUES IN THE SPACECRAFT
C COORDINATE SYSTEM, AND ALSO PROCESS EPHEMERIS INFORMATION
C
C DATA DESCRIPTION FOR UNIT IST1 INPUT TAPE(S)
C
C   IYR    = YEAR - 1900
C   IDAY   = DAY NUMBER (JAN FIRST = 1)
C   IETIME = TIME OF EPHEMERIS RECORD (SEC U.T.)
C   IALT   = ALTITUDE (NAUTICAL MILES)
C   GLAT   = GEOGRAPHIC LATITUDE
C   GLON   = GEOGRAPHIC LONGITUDE
C   GMLAT  = CORRECTED GEOMAGNETIC LATITUDE
C   GMLON  = CORRECTED GEOMAGNETIC LONGITUDE
C   XMLT   = CORRECTED GEOMAGNETIC LOCAL TIME
C   NS     = NUMBER OF DATA RECORDS FOLLOWING EPHEMERIS RECORD
C   IDSEC  = TIME OF DATA RECORD (SEC U.T.)
C   JD     = RAW MAGNETOMETER COUNTS:
C            OLD TAPE FORMAT --> 2 SAMPLES/SECOND, 3 AXES/SAMPLE
C            NEW TAPE FORMAT --> 20 SAMPLES/SECOND, 3 AXES/SAMPLE
C
      CHARACTER*24 FMT
      DIMENSION JD(3,20),EU(3),CA(3,3),QI(3),QF(3),CF(3),RF(3,3),RC(3,3)
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      REAL*8 TBEG,TEND,TCUR,DAYDIV
      COMMON /STFILE/ IST1,IST2,IST3,IST4
      COMMON /ARCLIM/ IARC,IYRBEG,IDYBEG,ISCBEG,IYREND,IDYEND,ISCEND,
     *                IFORM,NDATAR,INPUTF
      COMMON /COTRAN/ EU,CA,QI,QF,CF,RF,RC
C
C COMPUTE BEGIN (TBEG) AND END (TEND) YEAR TIME OF SATELLITE ARC TO BE
C PROCESSED, ACCOUNTING FOR LEAP YEARS
C
      DAYDIV=365.D0
      IF(MOD(IYRBEG,4).EQ.0) DAYDIV=366.D0
      TBEG=DBLE(IYRBEG)+(DBLE(IDYBEG)+(DBLE(ISCBEG)/86400.D0))/DAYDIV
      DAYDIV=365.D0
      IF(MOD(IYREND,4).EQ.0) DAYDIV=366.D0
      TEND=DBLE(IYREND)+(DBLE(IDYEND)+(DBLE(ISCEND)/86400.D0))/DAYDIV
C
C DETERMINE THE FORMAT (FMT) OF THE INPUT TAPE(S):
C IF IFORM = 0, USE OLD TAPE FORMAT --> 2 SAMPLES/SECOND, 3 AXES/SAMPLE
C IF IFORM = 1, USE NEW TAPE FORMAT --> 20 SAMPLES/SECOND, 3 AXES/SAMPLE
C
      IF(IFORM.EQ.0) FMT='(4I6,52X,5F10.2,I4)'
      IF(IFORM.EQ.1) FMT='(2I4,I6,I4,5F10.0,3X,I4)'
C
C COUNTER DEFINITIONS:
C
C NFREAD COUNTS NUMBER OF INPUT FILES THAT HAVE BEEN READ ON UNIT IST1
C NEPHEM COUNTS NUMBER OF EMPHEMERIS RECORDS READ
C NDRECT COUNTS TOTAL NUMBER OF DATA RECORDS READ
C NDRECP COUNTS NUMBER OF DATA RECORDS ELIGIBLE FOR PROCESSING
C NDRECA COUNTS NUMBER OF DATA RECORDS ACTUALLY PROCESSED WITHIN ARC
C
      NFREAD=1
      NEPHEM=0
      NDRECT=0
      NDRECP=0
      NDRECA=0
C
C READ INPUT DATA FROM AN INPUTF NUMBER OF ORIGINAL TAPES ON UNIT IST1
C
   10 READ(IST1,FMT,END=30) IYR,IDAY,IETIME,IALT,GLAT,GLON,GMLAT,GMLON,
     *XMLT,NS
      NEPHEM=NEPHEM+1
C
C COMPUTE CURRENT YEAR TIME (TCUR) FOR THIS DATA POINT, ACCOUNTING FOR
C LEAP YEARS
C
      DAYDIV=365.D0
      IF(MOD(IYR,4).EQ.0) DAYDIV=366.D0
      TCUR=DBLE(IYR)+(DBLE(IDAY)+(DBLE(IETIME)/86400.D0))/DAYDIV
C
C CONVERT ALTITUDE FROM NAUTICAL MILES TO KM
C
      ALT=REAL(IALT)*1.853
C
C READ RAW MAGNETOMETER DATA FOR EACH TIME INCREMENT IN SPACECRAFT
C COORDINATES. IF IFORM = 0 OR 1, THEN USE OLD OR NEW TAPE FORMAT,
C RESPECTIVELY
C
      IUTFLG=0
      DO 20 I=1,NS
```

```
      IF(IFORM.EQ.0) READ(IST1,100,END=30) IDSEC,((JD(MM,NN),NN=1,20),
     *MM=1,3)
      IF(IFORM.EQ.1) READ(IST1,101,END=30) IDSEC,((JD(MM,NN),MM=1,3),
     *NN=1,2)
  100 FORMAT(I6,4X,20I6/10X,20I6/10X,20I6)
  101 FORMAT(I6,5X,3I6,4X,3I6,4X)
C
C PROCESS FIRST NDATAR DATA RECORD AFTER EMPHEMERIS RECORD ONLY IF
C UNIVERSAL TIME OF FIRST DATA RECORD AND EPHEMERIS RECORD MATCH, THAT
C IS, IUTFLG = 0
C
      NDRECT=NDRECT+1
      IF(I.GT.NDATAR) GO TO 20
      IF((I.EQ.1).AND.(IETIME.NE.IDSEC)) IUTFLG=1
      IF(IUTFLG.EQ.1) GO TO 20
      NDRECP=NDRECP+1
C
C IF IARC = 0, THEN PROCESS ENTIRE SATELLITE ARC TAPE
C IF IARC = 1, THEN PROCESS SATELLITE ARC BETWEEN TBEG AND TEND ONLY
C
      IF((IARC.EQ.1).AND.((TCUR.LT.TBEG).OR.(TCUR.GT.TEND))) GO TO 20
      NDRECA=NDRECA+1
C
C TRANSFORM RAW SATELLITE MAGNETOMETER COUNTS INTO MAGNETIC FIELD
C COMPONENTS IN FIT (MAGSAT) SPACECRAFT COORDINATES BY PERFORMING:
C
C                    BS=RE*CF*(RF*(CA*M+QI)-QF)
C
C WHERE BS = MAGNETIC FIELD COMPONENTS IN FIT SPACECRAFT COORDINATES
C       RE = EULER ANGLE ADJUSTMENT MATRIX IN 1-3-2 ROTATION SYSTEM
C       CF = FIT CALIBRATION SLOPE ADJUSTMENT MATRIX
C       RF = ROTATION MATRIX FROM M TO BS COORDINATE SYSTEM
C       CA = CALIBRATION MATRIX IN ORIGINAL SPACECRAFT COORDINATES
C       M  = RAW MAGNETOMETER COUNTS IN ORIGINAL SPACECRAFT COORDINATES
C       QI = GSFC NOMINAL BIAS CORRECTIONS
C       QF = FIT MAGNETOMETER BIAS ADJUSTMENTS
C
C BS = (BX,BY,BZ) WHERE BX, BY, AND BZ ARE THE FIT/MAGSAT SPACECRAFT
C      COMPONENTS (CROSS-TRACK,RADIAL,ALONG-TRACK)
C
C M  = (XM,YM,ZM) WHERE XM, YM, AND ZM ARE THE ORIGINAL SPACECRAFT
C      MAGNETOMETER COMPONENTS
C
      XM=JD(1,1)
      YM=JD(2,1)
      ZM=JD(3,1)
C
C PERFORM:             P=CA*M+QI
C
      PX=CA(1,1)*XM+CA(1,2)*YM+CA(1,3)*ZM+QI(1)
      PY=CA(2,1)*XM+CA(2,2)*YM+CA(2,3)*ZM+QI(2)
      PZ=CA(3,1)*XM+CA(3,2)*YM+CA(3,3)*ZM+QI(3)
C
C PERFORM:             S=RF*P
C
      SX=RF(1,1)*PX+RF(1,2)*PY+RF(1,3)*PZ
      SY=RF(2,1)*PX+RF(2,2)*PY+RF(2,3)*PZ
      SZ=RF(3,1)*PX+RF(3,2)*PY+RF(3,3)*PZ
C
C PERFORM:             W=CF*(S-QF)
```

```
C
      WX=(SX-QF(1))/CF(1)
      WY=(SY-QF(2))/CF(2)
      WZ=(SZ-QF(3))/CF(3)
C
C PERFORM:         BS=RE*W
C
      CALL EULER(WX,WY,WZ,BX,BY,BZ)
C
C WRITE EPHEMERIS AND MAGNETIC FIELD INFORMATION TO STORAGE UNIT IST2
C
      WRITE(IST2,102) IYR,IDAY,IDSEC,ALT,GLAT,GLON,GMLAT,GMLON,BX,BY,BZ
  102 FORMAT(I2,I4,I6,5F7.2,3F8.1)
   20 CONTINUE
      GO TO 10
C
C FILE NUMBER NFREAD ON UNIT IST1 HAS JUST BEEN READ, COMPARE CURRENT
C NUMBER OF FILES READ (NFREAD) WITH TOTAL NUMBER OF FILES TO BE READ
C (INPUTF). IF ALL INPUT FILES HAVE BEEN READ, THEN RETURN TO FILTER.
C IF ADDITIONAL INPUT FILES HAVE NOT BEEN READ, THEN READ NEXT FILE
C
   30 IF(NFREAD.EQ.INPUTF) GO TO 40
C
C RECORD NUMBER OF NEXT FILE TO BE READ
C
      NFREAD=NFREAD+1
      GO TO 10
C
C DETERMINE TOTAL NUMBER OF RECORDS (NTOTR) READ ON UNIT IST1
C
   40 NTOTR=NEPHEM+NDRECT
C
C PRINT INPUT AND OUTPUT DATA SET INFORMATION FOR STEP1
C
      WRITE(6,103) IST1,NTOTR,NEPHEM,NDRECT,NDRECP,NDRECA,IST2,NDRECA
  103 FORMAT('1','**************************************************'/1
     *X,'**** P R E - F I L T E R   P R O C E S S I N G ****'/1X,'******
     *********************************************'///1X,'<STEP1 PROCES
     *SING>'//1X,'INPUT DATA TYPE:  RAW MAGNETOMETER COUNTS ON UNIT ',I2
     *//3X,'TOTAL RECORDS READ = ',I5//5X,'NUMBER OF EMPHEMERIS RECORDS
     *READ = ',I5/5X,'NUMBER OF DATA RECORDS READ = ',I5//7X,'NUMBER OF
     *DATA RECORDS ACCEPTED FOR PROCESSING = ',I5//9X,'NUMBER OF DATA RE
     *CORDS PROCESSED IN ARC SEGMENT = ',I5//1X,'OUTPUT DATA TYPE:  MAGN
     *ETIC FIELD COMPONENTS IN FIT/MAGSAT COORDINATES ON UNIT ',I2//3X,'
     *TOTAL RECORDS WRITTEN = ',I5//)
      RETURN
      END
      SUBROUTINE EULER(WX,WY,WZ,BX,BY,BZ)
C
C SUBROUTINE TO PERFORM EULER ANGLE ADJUSTMENT ON TEMPORARY W VECTOR
C WITH FULL ROTATION MATRIX:  RE=R1*R3*R2  CORRESPONDING TO ROTATIONS
C ABOUT EULER ANGLES EU(1), EU(3), AND EU(2), RESPECTIVELY
C
      DIMENSION EU(3),CA(3,3),QI(3),QF(3),CF(3),RF(3,3),RC(3,3)
      COMMON /COTRAN/ EU,CA,QI,QF,CF,RF,RC
C
C DETERMINE DEGREES-TO-RADIANS CONVERSION
C
      DTR=3.1415926530/180.0
C
```

```
C ADJUST SIGNS OF ANGLES SUPPLIED BY PROGRAM FIT AND CONVERT TO RADIANS
C
      EU1=-EU(1)*DTR
      EU2=-EU(2)*DTR
      EU3=EU(3)*DTR
C
C DETERMINE NEEDED TRIGONOMETRIC FUNCTIONS OF THE EULER ANGLES
C
      CE1=COS(EU1)
      SE1=SIN(EU1)
      CE2=COS(EU2)
      SE2=SIN(EU2)
      CE3=COS(EU3)
      SE3=SIN(EU3)
C
C PERFORM:          BS=RE*W
C
      BX=WX*(CE1*CE3)+WY*(CE1*SE3*CE2+SE1*SE2)+WZ*(CE1*SE3*SE2-SE1*CE2)
      BY=WX*(-SE3)+WY*(CE3*CE2)+WZ*(CE3*SE2)
      BZ=WX*(SE1*CE3)+WY*(SE1*SE3*CE2-CE1*SE2)+WZ*(SE1*SE3*SE2+CE1*CE2)
      RETURN
      END
      SUBROUTINE STEP2
C
C SUBROUTINE TO LOCATE AND PAD TIME GAPS IN THE DATA, AND DETERMINE THE
C DIRECTION OF THE SPACECRAFT VELOCITY VECTOR
C
      REAL*8 TIME,TIMEO
      COMMON /STFILE/ IST1,IST2,IST3,IST4
      COMMON /LIMITS/ DXOL,DYOL,DZOL,DBOL,XWINDO,YWINDO,ZWINDO,BWINDO,
     *                ABVLAT,TRNLAT,ITMGAP
      DATA IPASS /1/, MDIRO /-1/
C
C COUNTER DEFINITIONS:
C
C NTGAP COUNTS NUMBER OF PADDED TIME-GAP VALUES APPENDED TO OUTPUT DATA
C NDASC COUNTS NUMBER OF ASCENDING POINTS
C NDDSC COUNTS NUMBER OF DESCENDING POINTS
C NDTRN COUNTS NUMBER OF TURNING POINTS
C
      NTGAP=0
      NDASC=0
      NDDSC=0
      NDTRN=0
C
C INITIALLY REWIND STORAGE UNIT IST2 CREATED IN SUBROUTINE STEP1
C
      REWIND IST2
      READ(IST2,100) IYR,IDAYO,IETIMO
C
C CALL CLTIME WHEN FIRST POINT OF NEW PASS SEGMENT IS ENCOUNTERED
C
   10 CALL CLTIME(GLATO,TIMEO)
   20 READ(IST2,100,END=99) IYR,IDAY,IETIME,ALT,GLAT,GLON,GMLAT,GMLON,
     *BX,BY,BZ
  100 FORMAT(I2,I4,I6,5F7.2,3F8.1)
C
C AFTER READING NEXT DATA POINT ON UNIT IST2, DETERMINE ITS UNIVERSAL
C TIME AND COMPARE WITH UNIVERSAL TIME OF PREVIOUS POINT. IF TIME
C DIFFERENCE IS GREATER THAN ITMGAP SECONDS, THEN TIME GAP HAS OCCURRED
```

```
C AND NEW PASS SEGMENT IS INITIALIZED BY CLTIME
C
      TIME=DBLE(IDAY)+DBLE(IETIME)/86400.D0
      IF(TIME-TIMEO.GT.(DBLE(ITMGAP)+0.5D0)/86400.D0) GO TO 10
      TIMEO=TIME
C
C CALCULATE DELTA LATITUDE OF PRESENT POINT. IF A TIME GAP PRESENTLY
C EXISTS BETWEEN THE PRESENT AND PREVIOUS POINT, THEN USE A FORWARD
C DIFFERENCE BETWEEN THE PRESENT AND FOLLOWING DATA POINT (CALCULATED
C IN CLTIME), OTHERWISE, USE A BACKWARD DIFFERENCE. IF DELTA LATITUDE
C IS NON-NEGATIVE, THEN SATELLITE IS CONSIDERED ASCENDING, IF NEGATIVE,
C THEN DESCENDING. IF LATITUDE OF PRESENT POINT IS ABOVE +TRNLAT OR
C BELOW -TRNLAT DEGREES LATITUDE, THEN VELOCITY DIRECTION CANNOT BE
C ACCURATELY DETERMINED AND SATELLITE IS CONSIDERED TO BE TURNING (IDIR)
C
      DELAT=GLAT-GLATO
      IF(DELAT.GE.0.0) IDIR=1
      IF(DELAT.GE.0.0) MDIR=1
      IF(DELAT.LT.0.0) IDIR=-1
      IF(DELAT.LT.0.0) MDIR=-1
      IF(ABS(GLAT).GE.TRNLAT) IDIR=0
C
C IF SATELLITE DIRECTION CHANGES FROM DESCENDING TO ASCENDING (MDIR),
C THEN NEW PASS HAS BEGUN. CALL PASDEN TO PROCESS PRESENT DATA POINT
C WITHIN PROPER PASS
C
      IF((MDIRO.EQ.-1).AND.(MDIR.EQ.1)) IPASS=IPASS+1
      CALL PASDEN(GLAT,ALT,IPASS,MDIR)
C
C CHECK FOR TIME GAPS BETWEEN PRESENT AND PREVIOUS POINT THAT OCCUR ON
C SAME DAY
C
      IF(IDAY.EQ.IDAYO) THEN
       ITIME=IETIME-IETIMO
C
C IF A TIME GAP OF GREATER THAN ITMGAP SECONDS IS FOUND, THEN DETERMINE
C NUMBER OF ITMGAP SECOND PADS NEEDED AND WRITE THEM OUT TO UNIT IST3 AT
C PROPER TIME INTERVALS. INOTE = 2 INDICATES A PADDED TIME GAP VALUE.
C
       IF(ITIME.GT.ITMGAP) THEN
        INOTE=2
        IT=ITIME/ITMGAP-1
        DO 30 I=1,IT
        NTGAP=NTGAP+1
        ITIME=IETIMO+I*ITMGAP
   30   WRITE(IST3,101) IYR,IDAY,ITIME,INOTE
       END IF
C
C CHECK FOR TIME GAPS BETWEEN PRESENT AND PREVIOUS POINT THAT OCCUR ON
C DIFFERENT DAYS
C
      ELSE
       ITIME=86400-IETIMO+IETIME
C
C IF A TIME GAP OF GREATER THAN ITMGAP SECONDS IS FOUND, THEN DETERMINE
C NUMBER OF ITMGAP SECOND PADS NEEDED AND WRITE THEM OUT TO UNIT IST3 AT
C PROPER TIME INTERVALS. INOTE = 2 INDICATES A PADDED TIME GAP VALUE.
C
       IF(ITIME.GT.ITMGAP) THEN
        INOTE=2
```

```
        IT=ITIME/ITMGAP-1
        IDAYC=IDAYO
        DO 40 I=1,IT
        NTGAP=NTGAP+1
        ITIME=IETIMO+I*ITMGAP
        IF(ITIME.GE.86400) IDAYC=IDAY
        IF(ITIME.GE.86400) ITIME=ITIME-86400
   40   WRITE(IST3,101) IYR,IDAYC,ITIME,INOTE
       END IF
      END IF
C
C RESET DATA QUALITY FLAG INOTE = 0 INDICATING NO CONSTRAINTS ON DATA
C
      INOTE=0
C
C IF VELOCITY DIRECTION IS INDETERMINABLE (IDIR = 0), THEN SET INOTE = 7
C
      IF(IDIR.EQ.0) INOTE=7
C
C WRITE OUT PRESENT DATA POINT EPHEMERIS, MAGNETIC FIELD, AND VELOCITY
C VECTOR DIRECTION INFORMATION
C
      IF(IDIR.EQ.1) NDASC=NDASC+1
      IF(IDIR.EQ.-1) NDDSC=NDDSC+1
      IF(IDIR.EQ.0) NDTRN=NDTRN+1
      WRITE(IST3,102) IYR,IDAY,IETIME,ALT,GLAT,GLON,GMLAT,GMLON,BX,BY,
     *BZ,IDIR,INOTE
C
C INITIALIZATION FOR PROCESSING NEXT DATA POINT. SET PRESENT DATA POINT
C PARAMETERS TO PREVIOUS DATA POINT PARAMETERS
C
      MDIRO=MDIR
      GLATO=GLAT
      IDAYO=IDAY
      IETIMO=IETIME
      GO TO 20
C
C END OF FILE ON UNIT IST2, CALL PASDEN AT PASEND ENTRY POINT TO
C COMPLETE DATA DISTRIBUTION PLOTS
C
   99 CALL PASEND
C
C DETERMINE TOTAL NUMBER OF RECORDS (NTOTR) READ ON UNIT IST2
C DETERMINE TOTAL NUMBER OF RECORDS (NTOTW) WRITTEN ON UNIT IST3
C
      NTOTR=NDASC+NDDSC+NDTRN
      NTOTW=NTOTR+NTGAP
C
C PRINT INPUT AND OUTPUT DATA SET INFORMATION FOR STEP2
C
      WRITE(6,103) IST2,NTOTR,IST3,NTOTW,NDASC,NDDSC,NDTRN,NTGAP
  103 FORMAT(//1X,'<STEP2 PROCESSING>'//1X,'INPUT DATA TYPE:  MAGNETIC F
     *IELD COMPONENTS IN FIT/MAGSAT COORDINATES ON UNIT ',I2//3X,'TOTAL
     *RECORDS READ = ',I5//1X,'OUTPUT DATA TYPE:  SAME AS INPUT WITH VEL
     *OCITY DIRECTIONS AND PADDED TIME-GAP INFORMATION APPENDED ON UNIT
     *',I2//3X,'TOTAL RECORDS WRITTEN = ',I5//5X,'NUMBER OF ASCENDING PO
     *INTS = ',I5/5X,'NUMBER OF DESCENDING POINTS = ',I5/5X,'NUMBER OF T
     *URNING POINTS = ',I5/5X,'NUMBER OF TIME-GAP POINTS = ',I5//)
  101 FORMAT(I2,I4,I6,64X,I5)
  102 FORMAT(I2,I4,I6,5F7.2,3F8.1,2I5)
```

```
      RETURN
      END
      SUBROUTINE CLTIME(GLATO,TIMEO)
C
C DETERMINES THE TIME AND DELTA LATITUDE OF THE PRESENT RECORD
C THIS ROUTINE IS CALLED FOR INITIAL STARTS AND WHEN TIME GAPS ARE
C ENCOUNTERED IN THE DATA
C
      REAL*8 TIMEO
      COMMON /STFILE/ IST1,IST2,IST3,IST4
      BACKSPACE IST2
      READ(IST2,100,END=99) IYR,IDAYO,IETIMO,ALT,GLATO
      READ(IST2,100,END=99) IYR,IDAY,IETIM,ALT,GLAT
  100 FORMAT(I2,I4,I6,5F7.2,3F8.1)
      BACKSPACE IST2
      BACKSPACE IST2
C
C DETERMINE DELTA LATITUDE BY FORWARD DIFFERENCE, THEN ADJUST PRESENT
C DATA POINT LATITUDE GLATO SO THAT PROPER DELTA SIGN WILL BE DETERMINED
C IN SUBROUTINE STEP2
C
      DELAT=GLAT-GLATO
      IF(DELAT.GE.0.0) GLATO=GLATO-1.0
      IF(DELAT.LT.0.0) GLATO=GLATO+1.0
      TIMEO=DBLE(IDAYO)+DBLE(IETIMO)/86400.D0
      RETURN
   99 WRITE(6,101)
  101 FORMAT(/1X,'**** END OF FILE IN SUBROUTINE CLTIME ****')
      STOP
      END
      SUBROUTINE PASDEN(ALAT,ALT,IPASS,MDIR)
C
C THIS SUBROUTINE PLOTS THE DISTRIBUTION OF DATA POINTS BY PASS, AND
C ALSO CALCULATES AVERAGE ALTIUDE AND NUMBER OF POINTS PER PASS
C
      CHARACTER*1 P1(73) /73*' '/, STAR /'*'/, BLANK /' '/
      LOGICAL FIRST /.TRUE./, PRINT
      DATA ALTSUM /0.0/, NUM /0/, ICNT /0/
C
C ON FIRST CALL SETUP THE PLOT HEADING
C
      IF(FIRST) THEN
       FIRST=.FALSE.
       IPOLD=IPASS
       WRITE(6,100)
       WRITE(6,101)
      END IF
   10 IF(IPOLD.EQ.IPASS) THEN
C
C IF PRESENT DATA POINT BELONGS TO CURRENT PASS THEN CALCULATE
C RELATIVE POSITION IN P1 ARRAY (5 POINTS/ARRAY ELEMENT) DEPENDING UPON
C VELOCITY DIRECTION. ALSO CONTINUE POINT COUNT AND ALTITUDE SUMMATION
C
       IF(MDIR.EQ.1) THEN
        LAT=INT((ALAT+92.5)/5.0)+1
       ELSE
        LAT=INT((92.5-ALAT)/5.0)+37
       END IF
       P1(LAT)=STAR
       NUM=NUM+1
```

```
       ALTSUM=ALTSUM+ALT
       PRINT=.TRUE.
      ELSE
C
C IF PRESENT DATA POINT BELONGS TO A SUCCEEDING PASS THEN CALCULATE
C AVERAGE ALTITUDE FOR LAST PASS AND PRINT LAST PASS INFORMATION
C
       AVGALT=ALTSUM/REAL(NUM)
       WRITE(6,102) IPOLD,P1,NUM,AVGALT
       PRINT=.FALSE.
       ICNT=ICNT+1
C
C IF MORE THAN 50 PASSES HAVE BEEN PRINTED ON ONE PAGE, THEN SKIP PAGE
C
       IF(MOD(ICNT,50).EQ.0) THEN
        WRITE(6,101)
        WRITE(6,100)
        WRITE(6,101)
       END IF
C
C CLEAR P1 ARRAY AND RESET VARIABLES TO BEGIN PROCESSING NEW PASS
C
       DO 20 I=1,73
   20  P1(I)=BLANK
       NUM=0
       ALTSUM=0.0
       IPOLD=IPASS
       GO TO 10
      END IF
      RETURN
C
C ENTRY POINT AFTER LAST PASS ON DATA TAPE, PRINT LAST PASS INFORMATION
C
      ENTRY PASEND
      IF(NUM.NE.0) AVGALT=ALTSUM/REAL(NUM)
      IF(PRINT) WRITE(6,102) IPOLD,P1,NUM,AVGALT
      IF(PRINT) WRITE(6,101)
      RETURN
  100 FORMAT('1','<SATELLITE-PASS DENSITY DISTRIBUTIONS>'//42X,'TIME ---
     *>',10X,'(5 DEGREES PER *)')
  101 FORMAT(/1X,'PASS#      -9 -7 -6 -4 -3 -1  0  1  3  4  6  7  9  7  6
     *  4  3  1  0 -1 -3 -4 -6 -7 -9   <--- LAT    #POINTS    AVG ALT'/1
     *2X,'0  5  0  5  0  5  0  5  0  5  0  5  0  5  0  5  0  5  0  5  0
     * 5  0  5  0'/)
  102 FORMAT(1X,I5,6X,73A1,18X,I4,2X,F9.2)
      END
      SUBROUTINE STEP3
C
C SUBROUTINE TO TRANSFORM MAGNETIC FIELD MEASUREMENTS FROM SPACECRAFT
C TO TOPOCENTRIC COORDINATE SYSTEM, COMPUTE FIELD VALUES FROM INPUT
C MODEL, AND DETERMINE FIELD RESIDUALS (OBSERVED MINUS COMPUTED). FLAG
C DATA POINTS WHOSE RESIDUALS ARE GREATER THAN A SPECIFIED TOLERANCE
C
      REAL*8 COSLAT,SINALP,COSALP,SINDEL,SADCL,CAMSD,DTR
      COMMON /STFILE/ IST1,IST2,IST3,IST4
      COMMON /IFIELD/ JJ,MM,NMX,NEXT,IOCF,IDST,DST,LL
      COMMON /EPHEMS/ ORBINC,ERAD,IEPDAY,INCREM,INTRVL
      COMMON /LIMITS/ DXOL,DYOL,DZOL,DBOL,XWINDO,YWINDO,ZWINDO,BWINDO,
     *                ABVLAT,TRNLAT,ITMGAP
C
```

```
C CALCULATE DEGREES-TO-RADIANS CONVERSION
C
      DTR=3.141592653D0/180.D0
C
C COUNTER DEFINITIONS:
C
C NTOTR COUNTS TOTAL RECORDS READ ON UNIT IST3
C NTGAP COUNTS PADDED TIME-GAP POINTS NOT TRANSFORMED TO TOPOCENTRIC
C NDTRN COUNTS SATELLITE TURNING POINTS NOT TRANSFORMED TO TOPOCENTRIC
C NOUTX COUNTS NUMBER OF TOPOCENTRIC X GROSS-OUTLIERS
C NOUTY COUNTS NUMBER OF TOPOCENTRIC Y GROSS-OUTLIERS
C NOUTZ COUNTS NUMBER OF TOPOCENTRIC Z GROSS-OUTLIERS
C NOUTB COUNTS NUMBER OF TOPOCENTRIC B GROSS-OUTLIERS
C NTOTW COUNTS TOTAL RECORDS WRITTEN ON UNIT IST4
C
      NTOTR=0
      NTGAP=0
      NDTRN=0
      NOUTX=0
      NOUTY=0
      NOUTZ=0
      NOUTB=0
      NTOTW=0
C
C DETERMINE NEGATIVE COMPLEMENT ALPHA OF ORBIT INCLINATION ANGLE ORBINC
C
      ALPHA=ORBINC-90.0
C
C TRANSFER IFIELD COMMON PARAMETERS TO ARGUMENT LIST FOR SUBROUTINE FID
C
      J1=IOCF
      J2=JJ
      J3=MM
      J4=NEXT
      J5=IDST
      J6=NMX
      J7=LL
      P1=DST
C
C REWIND STORAGE UNIT IST3 AND BEGIN TO PROCESS DATA
C
      REWIND IST3
   10 READ(IST3,100,END=60) IYR,IDAY,IETIME,ALT,GLAT,GLON,GMLAT,GMLON,
     *BX,BY,BZ,IDIR,INOTE
  100 FORMAT(I2,I4,I6,5F7.2,3F8.1,2I5)
      NTOTR=NTOTR+1
C
C IF DATA POINT IS A PADDED TIME-GAP VALUE, THEN SKIP PROCESSING
C
      IF(INOTE.EQ.2) GO TO 20
C
C COMPUTE GEOCENTRIC LATITUDE AND RADIUS
C
      CALL GEOCEN(GLAT,GCLAT,ALT,CALT)
C
C TRANSFORM SPACECRAFT FIELD VECTOR INTO TOPOCENTRIC MAGNETIC FIELD
C VECTOR BY PERFORMING:
C
C                        BT=TS*BS
C
```

```
C WHERE BT = FIELD COMPONENTS IN CARTESIAN TOPOCENTRIC COORDINATES
C       TS = ROTATION MATRIX FROM SPACECRAFT TO TOPOCENTRIC COORDINATES
C       BS = MAGNETIC FIELD COMPONENTS IN FIT SPACECRAFT COORDINATES
C
C MATRIX TS HAS THE FOLLOWING FORM:
C
C       TS = (  SIN(ALPHA)/COS(GCLAT)    0  #COS(ALPHA)*SIN(DELTA) )
C            ( #COS(ALPHA)*SIN(DELTA)    0  -SIN(ALPHA)/COS(GCLAT) )
C            (             0             1             0           )
C
C WHERE ALPHA = NEGATIVE COMPLEMENT OF ORBIT INCLINATION
C       GCLAT = GEOCENTRIC LATITUDE
C       DELTA = ARCOS(TAN(GCLAT)*TAN(ALPHA))
C       #     = + FOR ASCENDING AND - FOR DESCENDING SATELLITE DATA
C
C BT = (TX,TY,TZ) WHERE TX, TY, AND TZ ARE THE CONVENTIONAL TOPOCENTRIC
C      COMPONENTS, THAT IS, (-BTHETA, BPHI, -BRHO)
C
C CALCULATE SCALAR FIELD VALUE IN TOPOCENTRIC COORDINATES
C
      BB=SQRT(BX*BX+BY*BY+BZ*BZ)
C
C IF VELOCITY DIRECTION CANNOT BE DETERMINED, THEN SKIP PROCESSING
C
      IF(IDIR.EQ.0) GO TO 30
C
C DETERMINE NEEDED TRIGONOMETRIC FUNCTIONS OF GCLAT, ALPHA, AND DELTA
C
      COSLAT=DCOS(DBLE(GCLAT)*DTR)
      SINALP=DSIN(DBLE(ALPHA)*DTR)
      COSALP=DCOS(DBLE(ALPHA)*DTR)
      SINDEL=DSIN(DACOS(DTAN(DBLE(GCLAT)*DTR)*DTAN(DBLE(ALPHA)*DTR)))
      SADCL=SINALP/COSLAT
      CAMSD=COSALP*SINDEL
      IF(IDIR.EQ.-1) GO TO 40
C
C PERFORM TRANSFORMATION IF SATELLITE IS ASCENDING
C
      TX=BX*SADCL+BZ*CAMSD
      TY=BX*CAMSD-BZ*SADCL
      GO TO 50
C
C PERFORM TRANSFORMATION IF SATELLITE IS DESCENDING
C
   40 TX=BX*SADCL-BZ*CAMSD
      TY=-BX*CAMSD-BZ*SADCL
   50 TZ=BY
C
C CALCULATE SCALAR FIELD VALUE IN SPACECRAFT COORDINATES
C
      TB=SQRT(TX*TX+TY*TY+TZ*TZ)
C
C DETERMINE TIME IN YEARS FOR CURRENT DATA POINT FOR INPUT TO FID
C
      TM=1900.0+REAL(IYR)+(REAL(IDAY)+(REAL(IETIME)/86400.0))/365.0
C
C DETERMINE THE COMPUTED FIELD VALUE FOR THIS POINT AT TIME TM USING THE
C MODEL THAT IS INPUT ON UNIT IOCF
C
      CALL FID(J1,J2,J3,J4,J5,GCLAT,GLON,CALT,TM,P1,J6,J7,CX,CY,CZ,CB)
```

```
C
C CALCULATE RESIDUAL MAGNETIC FIELD VALUES
C
      DX=TX-CX
      DY=TY-CY
      DZ=TZ-CZ
      DB=TB-CB
C
C FLAG POINTS WHOSE RESIDUAL VALUES ARE GREATER THAN SPECIFIED VALUES
C FOR ANY PARTICULAR COMPONENT, USING A FLAG OF INOTE = 1. WRITE
C MAGNETIC FIELD AND EPHEMERIS INFORMATION TO UNIT IST4
C
      IF((ABS(DX).GT.DXOL).OR.(ABS(DY).GT.DYOL).OR.(ABS(DZ).GT.DZOL).OR.
     *(ABS(DB).GT.DBOL)) INOTE=1
      IF(ABS(DX).GT.DXOL) NOUTX=NOUTX+1
      IF(ABS(DY).GT.DYOL) NOUTY=NOUTY+1
      IF(ABS(DZ).GT.DZOL) NOUTZ=NOUTZ+1
      IF(ABS(DB).GT.DBOL) NOUTB=NOUTB+1
      NTOTW=NTOTW+1
      WRITE(IST4,101) IYR,IDAY,IETIME,GLAT,GCLAT,GLON,GMLAT,GMLON,ALT,
     *CALT,BX,BY,BZ,BB,TX,TY,TZ,TB,DX,DY,DZ,DB,CX,CY,CZ,CB,IDIR,INOTE
  101 FORMAT(I2,I4,I6,7F7.2,4F8.1,32X,12F8.1,2I5)
      GO TO 10
C
C IF PADDED TIME-GAP VALUES ARE ENCOUNTERED, THEN WRITE INFORMATION TO
C UNIT IST4 USING A FLAG OF INOTE = 2
C
   20 NTGAP=NTGAP+1
      WRITE(IST4,102) IYR,IDAY,IETIME,INOTE
  102 FORMAT(I2,I4,I6,214X,I5)
      GO TO 10
C
C IF VELOCITY DIRECTION CANNOT BE DETERMINED FOR THIS DATA POINT, THEN
C WRITE SPACECRAFT FIELD VECTOR COMPONENTS ONLY TO UNIT IST4
C
   30 NDTRN=NDTRN+1
      WRITE(IST4,103) IYR,IDAY,IETIME,GLAT,GCLAT,GLON,GMLAT,GMLON,ALT,
     *CALT,BX,BY,BZ,BB,IDIR,INOTE
  103 FORMAT(I2,I4,I6,7F7.2,4F8.1,128X,2I5)
      GO TO 10
C
C DETERMINE POINT TOTAL OMITTED (NOMIT) FROM TOPOCENTRIC TRANSFORMATION
C DETERMINE POINT TOTAL FLAGGED (NFLAG) AS GROSS-OUTLIERS
C
   60 NOMIT=NTGAP+NDTRN
      NFLAG=NOUTX+NOUTY+NOUTZ+NOUTB
C
C PRINT INPUT AND OUTPUT DATA SET INFORMATION FOR STEP3
C
      WRITE(6,104) IST3,NTOTR,NOMIT,NTGAP,NDTRN,IST4,NTOTW,NFLAG,NOUTX,
     *NOUTY,NOUTZ,NOUTB
  104 FORMAT(//1X,'<STEP3 PROCESSING>'//1X,'INPUT DATA TYPE:  FIT/MAGSAT
     * FIELD COMPONENTS WITH APPENDED VELOCITY DIRECTION/TIME-GAP INFORM
     *ATION ON UNIT ',I2//3X,'TOTAL RECORDS READ = ',I5//5X,'TOTAL RECOR
     *DS OMITTED FROM TOPOCENTRIC TRANSFORMATION = ',I5//7X,'TIME-GAP OM
     *ISSIONS = ',I5/7X,'SATELLITE TURNING POINT OMISSIONS = ',I5//1X,'O
     *UTPUT DATA TYPE:  MAGNETIC FIELD AND RESIDUALS IN TOPOCENTRIC COOR
     *DINATES ON UNIT ',I2//3X,'TOTAL RECORDS WRITTEN = ',I5//5X,'TOTAL
     *GROSS-OUTLIERS = ',I5//7X,'TOPOCENTRIC X OUTLIERS = ',I5/7X,'TOPOC
     *ENTRIC Y OUTLIERS = ',I5/7X,'TOPOCENTRIC Z OUTLIERS = ',I5/7X,'TOP
```

```
     *OCENTRIC B OUTLIERS = ',I5//)
      RETURN
      END
      SUBROUTINE GEOCEN(GLAT,GCLAT,ALT,CALT)
C
C CONVERT GEODETIC LATITUDE (GLAT) AND ALTITUDE (ALT) TO GEOCENTRIC
C LATITUDE (GCLAT) AND RADIUS (CALT)
C
      IMPLICIT REAL*8(A-H,O-Z)
      REAL*4 GLAT,GCLAT,ALT,CALT
      DTR=3.141592653D0/180.D0
C
C A = EQUITORIAL RADIUS, E = OPTICAL FLATTENING, BOA = RATIO OF POLAR TO
C EQUITORIAL RADII, AN = EAST-WEST RADIUS OF CURVATURE
C
      A=6378.16D0
      E=1.D0/298.25D0
      BOA=1.D0-E
      AN=A/DSQRT(DCOS(GLAT*DTR)**2+(BOA*DSIN(GLAT*DTR))**2)
C
C CALCULATE GCLAT AND CALT USING PYTHAGOREAN RELATIONSHIPS
C
      H=ALT
      TOP=(BOA**2*AN+H)*DSIN(GLAT*DTR)
      BOT=(AN+H)*DCOS(GLAT*DTR)
      GCLAT=DATAN2(TOP,BOT)/DTR
      CALT=DSQRT(BOT**2+TOP**2)
      RETURN
      END
      SUBROUTINE TRANSF(PHIR,ALAMR,IDIR,RH,ANORM,VH)
C
C SUBROUTINE TO CREATE TRANSFORMATION MATRIX BETWEEN SPACECRAFT AND
C GEOCENTRIC COORDINATE SYSTEMS
C
C ORBINC = ANGLE OF ORBIT INCLINATION
C RH     = SATELLITE POSITION VECTOR IN (X,Y,Z) COORDINATES
C ANORM  = ORBIT NORMAL VECTOR IN (X,Y,Z) COORDINATES
C VH     = SATELLITE VELOCITY VECTOR IN (X,Y,Z) COORDINATES
C PHIR   = GEOCENTRIC LATITUDE OF POSITION VECTOR
C PHIN   = GEOCENTRIC LATITUDE OF NORMAL VECTOR
C ALAMR  = LONGITUDE OF POSITION VECTOR
C ALAMN  = LONGITUDE OF NORMAL VECTOR
C IDIR   = VELOCITY VECTOR DIRECTION:  +1 --> ASCENDING
C                                       0 --> TURN AROUND
C                                      -1 --> DESCENDING
C
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION RH(3),ANORM(3),VH(3)
      REAL*4 ORBINC,ERAD
      COMMON /EPHEMS/ ORBINC,ERAD,IEPDAY,INCREM,INTRVL
      DTR=3.141592654D0/180.D0
C
C PHIN IS THE COMPLEMENT OF THE ANGLE OF INCLINATION
C
      PHIN=90.D0-DBLE(ORBINC)
C
C INITIALIZE POSITION, NORMAL, AND VELOCITY VECTORS FOR NEXT MATRIX
C
      DO 10 I=1,3
      RH(I)=0.D0
```

```
      ANORM(I)=0.D0
   10 VH(I)=0.D0
C
C IF SATELLITE IS TURNING THEN ORBIT NORMAL CANNOT BE DETERMINED
C
      IF(IDIR.NE.0) GO TO 20
      WRITE(6,100) PHIR,ALAMR
  100 FORMAT(/1X,'ATTENTION:  CANNOT FIND ORBIT NORMAL VECTOR FOR TURNIN
     *G POINT AT LATITUDE: ',F7.2,' LONGITUDE: ',F7.2)
      RETURN
C
C CALCULATE LONGITUDE DIFFERENCE BETWEEN POSITION AND NORMAL VECTORS
C DETERMINE WHICH QUADRANT NORMAL LONGITUDE LIES IN
C
   20 ANGLE=DARCOS(-DTAN(PHIR*DTR)*DTAN(PHIN*DTR))/DTR
      IF(IDIR.EQ. 1) ALAMN=ALAMR-ANGLE
      IF(IDIR.EQ.-1) ALAMN=ALAMR+ANGLE
C
C TRANSFORMATION FROM SPHERICAL TO CARTESIAN COORDINATES FOR POSITION
C AND NORMAL VECTORS
C
      RH(1)=DCOS(PHIR*DTR)*DCOS(ALAMR*DTR)
      RH(2)=DCOS(PHIR*DTR)*DSIN(ALAMR*DTR)
      RH(3)=DSIN(PHIR*DTR)
      ANORM(1)=DCOS(PHIN*DTR)*DCOS(ALAMN*DTR)
      ANORM(2)=DCOS(PHIN*DTR)*DSIN(ALAMN*DTR)
      ANORM(3)=DSIN(PHIN*DTR)
C
C DETERMINE VELOCITY VECTOR FROM CROSS PRODUCT OF POSTION AND NORMAL
C VECTORS:  (ANORM X RH) = VH
C
      VH(1)=ANORM(2)*RH(3)-RH(2)*ANORM(3)
      VH(2)=ANORM(3)*RH(1)-RH(3)*ANORM(1)
      VH(3)=ANORM(1)*RH(2)-RH(1)*ANORM(2)
      RETURN
      END
      SUBROUTINE FID (IU,J,MM,NEXT,IDST,DLAT,DLONG,Q1,TM,DST,NMX,L,X,Y,
     *Z,F)
C***********************************************************************
C
C  FID INPUT PARAMETERS:
C
C  J .EQ. 0         INPUTS LATITUDE AND ALTITUDE (KM) RELATIVE TO
C                   ELLIPSOID (GEODETIC COORDINATES). OUTPUT FIELD
C                   COMPONENTS NORTH, EAST, VERTICAL IN GEODETIC
C                   COORDINATES
C
C  J .NE. 0         INPUTS LATITUDE AND LONGITUDE IN GEOCENTRIC
C                   COORDINATES AND GEOCENTRIC RADIUS (KM). OUTPUT FIELD
C                   COMPONENTS NORTH, EAST, VERTICAL IN SPHERICAL
C                   COORDINATES
C
C  MM .EQ. 0        USE DEFAULT VALUES AE=6378.16, FLAT=298.25
C  MM .NE. 0        INPUT VALUES FOR AE AND FLAT ON FIRST CALL TO FID
C
C  NEXT .EQ. 0      DO NOT EVALUATE EXTERNAL FIELD MODEL, DO NOT READ
C                   INPUT VALUES FOR EXTERNAL FIELD PARAMETERS WHEN L IS
C                   GREATER THAN 0
C  NEXT .NE. 0      EVALUATE EXTERNAL FIELD MODEL, READ INPUT VALUES FOR
C                   EXTERNAL FIELD PARAMETERS WHEN L IS GREATER THAN 0
```

```
C
C  IDST .EQ. 0     DO NOT EVALUATE INDUCED COEFFICIENTS
C  IDST .EQ. 1     EVALUATE INDUCED COEFFICIENTS
C
C  DLAT            GEODETIC LATITUDE IN DEGREES WHEN J = 0
C                  GEOCENTRIC LATITUDE IN DEGREES WHEN J = 1
C
C  DLONG           LONGITUDE IN DEGREES
C
C  Q1              GEODETIC ALTITUDE (KM) WHEN J = 0
C                  GEOCENTRIC RADIUS (KM) WHEN J = 1
C
C  NMX             MAXIMUM DEGREE OF MODEL EVALUATION
C
C  DST             DST VALUE
C
C  NMAX            MAXIMUM DEGREE AND ORDER OF CONSTANT FIELD TERMS
C  NMAXT           MAXIMUM DEGREE AND ORDER OF FIRST ORDER TIME TERMS
C  NMAXTT          MAXIMUM DEGREE AND ORDER OF SECOND ORDER TIME TERMS
C  NMXTTT          MAXIMUM DEGREE AND ORDER OF THIRD ORDER TIME TERMS
C
C  K .EQ. 0        FIELD MODEL COEFFICIENTS SCHMIDT NORMALIZED
C  K .NE. 0        FIELD MODEL COEFFICIENTS GAUSS NORMALIZED
C
C  TZERO           EPOCH TIME FOR FIELD MODEL COEFFICIENTS
C
C  TM              TIME OF PARTICULAR FIELD EVALUATION
C
C  ABAR            MEAN RADIUS USED IN FIELD MODEL POTENTIAL EXPANSION
C                  (DEFAULT = 6371.2)
C
C  MODEXT .EQ. 0   NO EXTERNAL FIELD SOLVED WITH MODEL
C  MODEXT .NE. 0   EXTERNAL FIELD SOLVED WITH MODEL
C
C  MODIND .EQ. 0   NO INDUCED COEFFS SOLVED WITH MODEL
C  MODIND .NE. 0   INDUCED COEFFS SOLVED WITH MODEL
C
C  L .EQ. 0        EVALUATE FIELD
C  L .GT. 0        READ IN FIELD MODEL AND EVALUATE FIELD
C  L .LT. 0        EVALUATE FIELD AT OLD TIME
C
C***********************************************************************
      EQUIVALENCE (SHMIT(1,1),TG(1,1))
      COMMON /COEFFS/TG(31,31)
      COMMON/INDUCE/IIDST,ALFA1,ALFA2,ALFA3,ALFA4,DSTT
      COMMON /FLDCOM/ST,CT,SPH,CPH,R,NMAX,BT,BP,BR,B,
     &ABAR,E1,E2,E3,NEXTF,Q(5,5)
      DIMENSION G(31,31),GT(31,31),SHMIT(31,31),AID(33)
      DIMENSION GTTT(8,8),GTT(31,31)
      DATA IFRST/0/
      DATA AE,FLAT/6378.16,298.25/
      DATA TLAST/0./
      DATA TABAR/6371.2/
      IF(IFRST) 110,100,110
C                                                             C
C        EQUATORIAL EARTH RADIUS AND FLATTENING FACTOR        C
C        USED IN GEODETIC-GEOCENTRIC COORDINATES.             C
C                                                             C
C        THE MODEL ITSELF IS INDEPENDENT OF THOSE             C
C        PARAMETERS                                           C
```

```
C                                                                C
  100 IF(MM.NE.0)READ(IU,101) AE,FLAT
  101 FORMAT(1X,2F6.1)
      WRITE(6,112)
  112 FORMAT('1','<INPUT MAGNETIC FIELD MODEL INFORMATION>')
      WRITE(6,109) AE,FLAT
  109 FORMAT(//5X,'CONSTANTS USED : '/,22X,'EQUATORIAL EARTH RADIUS  ',
     &F8.3/,22X,'EARTH RECIPROCAL FLATTENING  ',F6.1//)
      IFRST=1
      FLAT=1. -1./FLAT
      E1=0.
      E2=0.
      E3=0.
          ALFA1=0.
          ALFA2=0.
          ALFA3=0.
          ALFA4=0.
      A2=AE**2
      A4=AE**4
      B2=(AE*FLAT)**2
      A2B2=A2*(1.-FLAT**2)
      A4B4=A4*(1.-FLAT**4)
  110 IF (L) 19,1,2
1     IF (TM-TLAST) 17,19,17
2     READ (IU,3) NMAX,NMAXT,NMAXTT,NMXTTT,MODEXT,K,TZERO,ABAR,MODIND,
     &(AID(I),I=1,13)
3     FORMAT(4I2,2I2,2F6.1,I2,12A4,A2)
      IF(ABAR.EQ.0.) ABAR=TABAR
      READ(IU,103) (AID(I),I=14,33)
103   FORMAT(20A4)
      L=0
      WRITE (6,104) (AID(I),I=1,33)
104   FORMAT (25X,12A4,A2/5X,20A4//)
      WRITE(6,105) NMAX,NMAXT,NMAXTT,NMXTTT,MODEXT,K,TZERO,ABAR,NEXT
 105  FORMAT(5X,'FIELD MODEL ORDER (',I2,',',I2,',',I2,',',I2,')'/,
     .5X,'EXTERNAL FIELD SOLVED WITH MODEL ( 0-NO;.GT.0-DEGREE)',I2/,
     .5X,'NORMALIZATION (K=0-SCHMIDT ; K.NE.0-GAUSS)',I2/,
     .5X,'FIELD MODEL EPOCH  ',F6.1/,
     .5X,'FIELD MODEL MEAN RADIUS ',F6.1/,
     .5X,'EVALUATE EXTERNAL FIELD TO DEGREE',I2//)
      MAXN=0
      TEMP=0.
 5     READ (IU,6) N,M,GNM,HNM,GTNM,HTNM,GTTNM,HTTNM
6     FORMAT (2I3,6F11.4)
C         N=NL + 1
C         M=ML + 1
      IF (N.LE.0) GOTO7
      MAXN=(MAX0(N,MAXN))
      G(N,M)=GNM
      GT(N,M)=GTNM
      GTT(N,M)=GTTNM
      TEMP=AMAX1(TEMP,ABS(GTNM))
      IF (M.EQ.1) GOTO5
      G(M-1,N)=HNM
      GT(M-1,N)=HTNM
      GTT(M-1,N)=HTTNM
      GO TO 5
7     IF(NMXTTT.EQ.0) GO TO 107
106   READ(IU,6)N,M,GTTTNM,HTTTNM
      IF(N.EQ.0) GO TO 107
```

```
      IF(N.GT.8) STOP 106
      GTTT(N,M)=GTTTNM
      IF(M.EQ.1) GO TO 106
      GTTT(M-1,N)=HTTTNM
      GO TO 106
107   CONTINUE
C                                READ EXTERNAL FIELD
      IF(MODEXT.NE.0) THEN
 30     READ(IU,6) N,M,QNM,SNM
        IF(N .LE. 0) GO TO 31
        Q(N,M) = QNM
        IF(M .EQ. 1) GO TO 30
        Q(M-1,N) = SNM
        GO TO 30
      END IF
 31   CONTINUE
      IF(MODIND.NE.0.AND.IDST.NE.0) READ(IU,102)ALFA1,ALFA2,ALFA3,
     .      ALFA4
102   FORMAT(6X,4F11.4)
      WRITE(6,8)
8     FORMAT(6H0 N  M,6X,1HG,10X,1HH,9X,2HGT,9X,2HHT,8X,3HGTT,
     .8X,3HHTT,7X,4HGTTT,7X,4HHTTT//)
      DO 12 N=2,MAXN
      DO 12 M=1,N
      MI=M-1
      IF (M.EQ.1) GOTO10
      IF(N.GT.NMXTTT) WRITE(6,9)N,M,G(N,M),G(MI,N),
     .GT(N,M),GT(MI,N),GTT(N,M),GTT(MI,N)
      IF(N.LE.NMXTTT) WRITE(6,9)N,M,G(N,M),G(MI,N),
     .GT(N,M),GT(MI,N),GTT(N,M),GTT(MI,N),GTTT(N,M),GTTT(MI,N)
9     FORMAT(2I3,8F11.4)
      GO TO 12
10    CONTINUE
      IF(N.GT.NMXTTT) WRITE(6,11)N,M,G(N,M),GT(N,M),
     &GTT(N,M)
      IF(N.LE.NMXTTT) WRITE(6,11)N,M,G(N,M),GT(N,M),
     &GTT(N,M),GTTT(N,M)
11    FORMAT(2I3,F11.4,11X,F11.4,11X,F11.4,11X,F11.4)
12    CONTINUE
      IF(MODEXT.NE.0) THEN
            WRITE(6,108)
          DO 32 N = 2,MODEXT
          DO 32 M = 1,N
            IF(M .EQ. 1) SNM = 0.0
            IF(M .NE. 1) SNM = Q(M-1,N)
            WRITE(6,6) N,M,Q(N,M),SNM
 32       CONTINUE
      END IF
      IF(IDST.NE.0) WRITE(6,111) ALFA1,ALFA2,ALFA3,ALFA4
111     FORMAT(//5X,'INDUCED COEFFS, ',4F10.4)
108     FORMAT(//5X,8HEXTFLD, /)
 13     FORMAT (1H1)
      IF (TEMP.EQ.0.) L=-1
14    IF (K.NE.0) GOTO17
      SHMIT(1,1)=-1.
      DO 15 N=2,MAXN
      SHMIT(N,1)=SHMIT(N-1,1)*FLOAT(2*N-3)/FLOAT(N-1)
      SHMIT(1,N)=0.
      JJ=2
      DO 15 M=2,N
```

```
      SHMIT(N,M)=SHMIT(N,M-1)*SQRT(FLOAT((N-M+1)*JJ)/FLOAT(N+M-2))
      SHMIT(M-1,N)=SHMIT(N,M)
15    JJ=1
C         WRITE(6,300)
C300      FORMAT('   FID SCHMIT')
      DO 16 N=2,MAXN
      DO 16 M=1,N
      G(N,M)=G(N,M)*SHMIT(N,M)
      GT(N,M)=GT(N,M)*SHMIT(N,M)
      GTT(N,M)=GTT(N,M)*SHMIT(N,M)
      IF(NMXTTT.GT.0.AND.N.LE.8)GTTT(N,M)=GTTT(N,M)*SHMIT(N,M)
      IF (M.EQ.1) GOTO16
      G(M-1,N)=G(M-1,N)*SHMIT(M-1,N)
      GT(M-1,N)=GT(M-1,N)*SHMIT(M-1,N)
      GTT(M-1,N)=GTT(M-1,N)*SHMIT(M-1,N)
      IF(NMXTTT.GT.0.AND.N.LE.8)GTTT(M-1,N)=GTTT(M-1,N)*SHMIT(M-1,N)
16    CONTINUE
      IF(MODEXT .NE. 0) THEN
        DO 33 N = 2,MODEXT
        DO 33 M = 1,N
          Q(N,M) = Q(N,M)*SHMIT(N,M)
          IF(M .EQ. 1) GO TO 33
          Q(M-1,N) = Q(M-1,N)*SHMIT(M-1,N)
 33     CONTINUE
      END IF
C         WRITE(6,310)
C310      FORMAT('   FID COEF')
17    T=TM-TZERO
      DO 18 N=1,MAXN
      DO 18 M=1,N
      TGX=0.
      THX=0.
      IF(M.EQ.1) GO TO 270
      IF(N.GT.NMXTTT) GO TO 210
      TGX=GTTT(N,M)*T
      THX=GTTT(M-1,N)*T
210   IF(N.GT.NMAXTT) GO TO 220
      TGX=(TGX + GTT(N,M))*T
      THX= (THX + GTT(M-1,N))*T
220   IF(N.GT.NMAXT) GO TO 230
      TGX=(TGX + GT(N,M))*T
      THX=(THX+GT(M-1,N))*T
230   TGX=TGX+G(N,M)
      THX=THX+G(M-1,N)
      TG(N,M)=TGX
      TG(M-1,N)=THX
      GO TO 18
 270  CONTINUE
      IF(N.GT.NMXTTT) GO TO 240
      TGX=GTTT(N,M)*T
240   IF(N.GT.NMAXTT) GO TO 250
      TGX=(TGX+GTT(N,M))*T
250   IF(N.GT.NMAXT) GO TO 260
      TGX=(TGX+GT(N,M))*T
260   TGX= TGX+G(N,M)
      TG(N,M)=TGX
 18   CONTINUE
      TLAST=TM
19    DLATR=DLAT/57.2957795D0
      SINLA=SIN(DLATR)
```

```
      RLONG=DLONG/57.2957795D0
      CPH=COS(RLONG)
      SPH=SIN(RLONG)
      IF (J.EQ.0) GOTO20
C
C         Q1 IS GEOCENTRIC RADIUS WHEN J=1
C
      R=Q1
      CT=SINLA
      GO TO 21
20    SINLA2=SINLA**2
C
C         Q1 IS GEODETIC ALTITUDE WHEN J=0
C         ALT=Q1
C
      COSLA2=1.-SINLA2
      DEN2=A2-A2B2*SINLA2
      DEN=SQRT(DEN2)
      FAC=(((Q1*DEN)+A2)/((Q1*DEN)+B2))**2
      CT=SINLA/SQRT(FAC*COSLA2+SINLA2)
      R=SQRT(Q1*(Q1+2.*DEN)+(A4-A4B4*SINLA2)/DEN2)
21    ST=SQRT(1.-CT**2)
C         WRITE(6,330) DLAT,DLONG,R,TM
 330      FORMAT('  FID  ',4F12.4)
      NMAX=MIN0(NMX,MAXN)
      NEXTF=NEXT
          DSTT=DST
          IIDST=IDST
      CALL MAGF
      Y=BP
      F=B
      IF (J) 22,23,22
22    X=-BT
      Z=-BR
      RETURN
C     TRANSFORMS FIELD TO GEODETIC DIRECTIONS
23    SIND=SINLA*ST-SQRT(COSLA2)*CT
      COSD=SQRT(1.0-SIND**2)
      X=-BT*COSD-BR*SIND
      Z=BT*SIND-BR*COSD
      RETURN
      END
C
      SUBROUTINE MAGF
      DIMENSION P(31,31),DP(31,31),CONST(31,31),SP(31),CP(31),FN(31),
     .     FM(31),DXDQ(31,31),DXDS(31,31),DYDQ(31,31),DYDS(31,31),
     .     DZDQ(31,31),DZDS(31,31)
      COMMON /INDUCE/ IDST,ALFA1,ALFA2,ALFA3,ALFA4,DST
      COMMON /COEFFS/ G(31,31)
      COMMON /FCORE/ BRC,BTC,BPC,BC,BNEXT
      COMMON /FLDCOM/ ST,CT,SPH,CPH,R,NMAX,BT,BP,BR,B,ABAR,E1,E2,E3,
     .     NEXT,Q(31,31)
      DATA NCORE/14/
      IF (P(1,1).EQ.1.0) GO TO 3
1     P(1,1)=1.
      DP(1,1)=0.
      SP(1)=0.
      CP(1)=1.
      DO 2 N=2,NMAX
      FN(N)=N
```

```
      DO 2 M=1,N
      FM(M)=M-1
 2    CONST(N,M)=FLOAT((N-2)**2-(M-1)**2)/FLOAT((2*N-3)*(2*N-5))
 3    SP(2)=SPH
      CP(2)=CPH
      DO 4 M=3,NMAX
      SP(M)=SP(2)*CP(M-1)+CP(2)*SP(M-1)
 4    CP(M)=CP(2)*CP(M-1)-SP(2)*SP(M-1)
      AOR=ABAR/R
      AR=AOR**2
          BTC=0.0
          BPC=0.0
          BRC=0.0
          BC=0.0
      BT=0.
      BP=0.
      BR=0.
          IF(IDST.EQ.0) GO TO 12
          GBAR=G(2,1)
          G(2,1)=GBAR + ALFA1*DST
C         E1BAR=E1
C         E2BAR=E2
C         E3BAR=E3
C         E1=E1 + ALFA2*DST
C         E2=E2 + ALFA3*DST
C         E3=E3 + ALFA4*DST
          E1BAR = Q(2,1)
          E2BAR = Q(2,2)
          E3BAR = Q(1,2)
          Q(2,1) = Q(2,1) + ALFA2*DST
          Q(2,2) = Q(2,2) + ALFA3*DST
          Q(1,2) = Q(1,2) + ALFA4*DST
  12       CONTINUE
          DO 8 N=2,NMAX
      AR=AOR*AR
      DO 8 M=1,N
      IF (N-M) 6,5,6
 5    P(N,N)=ST*P(N-1,N-1)
      DP(N,N)=ST*DP(N-1,N-1)+CT*P(N-1,N-1)
      GO TO 7
 6    P(N,M)=CT*P(N-1,M)-CONST(N,M)*P(N-2,M)
C
C         NOTE : CONST(2,1)=0
C
      DP(N,M)=CT*DP(N-1,M)-ST*P(N-1,M)-CONST(N,M)*DP(N-2,M)
 7    PAR=P(N,M)*AR
      IF (M.EQ.1) GO TO 9
      TEMP=G(N,M)*CP(M)+G(M-1,N)*SP(M)
      BP=BP-(G(N,M)*SP(M)-G(M-1,N)*CP(M))*FM(M)*PAR
      GO TO 10
 9    TEMP=G(N,M)*CP(M)
 10   BT=BT+TEMP*DP(N,M)*AR
      BR=BR-TEMP*FN(N)*PAR
          IF(N.GT.NCORE) GO TO 8
          BTC=BT
          BRC=BR
          BPC=BP
  8       CONTINUE
      BP=BP/ST
          BPC=BPC/ST
```

```
          BNEXT=SQRT(BT*BT + BP*BP + BR*BR)
      IF(NEXT.GT.0) THEN
CCC
          MONO = 2
          SIND = 0.0
          COSD = 1.0
          CX = -BT
          CY =  BP
          CZ = -BR
C       IF(EXTFLD.EQ.0) GO TO 14
          ROA= 1.0/AOR
          RB= (ROA)**(2*(MONO-2)+1)
          ROA2= ROA*ROA
        DO 11 N= MONO,NEXT
          FNC= N-1
          RB= RB*ROA2
        DO 11 M= 1,N
          FMC= M-1
          P(N,M)= P(N,M)*RB
          DP(N,M)= DP(N,M)*RB
           TEMP= -FNC*P(N,M)*SIND - DP(N,M)*COSD
          DXDQ(N,M)= TEMP*CP(M)
          DXDS(N,M)= TEMP*SP(M)
           TEMP= FMC*P(N,M)/ST
          DYDQ(N,M)= -TEMP*SP(M)
          DYDS(N,M)= TEMP*CP(M)
           TEMP= -FNC*P(N,M)*COSD + DP(N,M)*SIND
          DZDQ(N,M)= TEMP*CP(M)
          DZDS(N,M)= TEMP*SP(M)
          IF(M .EQ. 1) THEN
            CX= CX + Q(N,M)*DXDQ(N,M)
            CY= CY + Q(N,M)*DYDQ(N,M)
            CZ= CZ + Q(N,M)*DZDQ(N,M)
          ELSE
            CX= CX + Q(N,M)*DXDQ(N,M) + Q(M-1,N)*DXDS(N,M)
            CY= CY + Q(N,M)*DYDQ(N,M) + Q(M-1,N)*DYDS(N,M)
            CZ= CZ + Q(N,M)*DZDQ(N,M) + Q(M-1,N)*DZDS(N,M)
          END IF
  11    CONTINUE
        BRC = BRC + (-CZ - BR)
        BPC = BPC + ( CY - BP)
        BTC = BTC + (-CX - BT)
          BT = -CX
          BP =  CY
          BR = -CZ
CCC
      END IF
          B=SQRT(BT*BT+BP*BP+BR*BR)
C                                                **** B(14 - 30) ***
          BC=SQRT(BTC*BTC + BRC*BRC + BPC*BPC)
          BTC=BT - BTC
          BPC=BP - BPC
          BRC=BR - BRC
          BC= B - BC
          IF(IDST.EQ.0) RETURN
       IF(ABS(DST).LT.1.E-4.AND.DST.NE.0.) WRITE(6,999)ST,CT,SPH,CPH,R,
     .       DST,E1
 999     FORMAT(10X,5F10.3,5X,2E20.12)
C         E1=E1BAR
C         E2=E2BAR
```

```
 C          E3=E3BAR
            Q(2,1) = E1BAR
            Q(2,2) = E2BAR
            Q(1,2) = E3BAR
            G(2,1)=GBAR
            RETURN
      END
      SUBROUTINE EXTFLD
      COMMON/FLDCOM/ST,CT,SPH,CPH,R,NMAX,BT,BP,BR,B,ABAR,E1,E2,E3
          COMMON/FCORE/BRC,BTC,BPC
      T1=E2*CPH+E3*SPH
      T2=E1*ST-T1*CT
      T1=E1*CT+T1*ST
      BR=BR-T1
      BP=BP+E2*SPH-E3*CPH
      BT=BT+T2
          BRC=BRC - T1
          BPC=BPC + E2*SPH - E3*CPH
          BTC=BTC + T2
      RETURN
      END
      SUBROUTINE STEP4(*,*)
C
C SUBROUTINE TO FIT A TREND TO MAGNETIC FIELD RESIDUALS (OBSERVED MINUS
C COMPUTED) WITH A B-SPLINE AND/OR FOURIER WAVEFORMS, WITH THE OPTION OF
C FLAGGING POINTS WHOSE TREND RESIDUALS LIE OUTSIDE A GIVEN TOLERANCE
C LEVEL AND/OR DETRENDING THE ORIGINAL DATA
C
      CHARACTER*1 CLABEL(3)
      INTEGER H(3)
      DIMENSION NN(3),NT(3),KA(3),ITERMX(3),LGRMAX(3),EPS(3),KEEPDQ(8)
      DIMENSION KO(3),EKNOTS(3,500),FREQ(3,500),SIG(3,500),ICLASS(3,8)
      REAL*8 BSPLX(500),BSPLY(500),V(5,500),COEF(500),D(13000)
      REAL*8 GSIG(5,500),EKN(500),FRQ(500),SIGCOM(500),RESID(500)
      REAL*8 TS,TF,WTRMS,AKNOT
      COMMON /STFILE/ IST1,IST2,IST3,IST4
      COMMON /MDFILE/ IOR,IOW,IOF,IOD,IOB,IOF1ST,IOD1ST,IOW1ST,IOWIOF
      COMMON /SCFILE/ ISC1,ISC2,ISC3
      COMMON /SPLINE/ H,NN,NT,KA,ITERMX,LGRMAX,EPS,KO,SIG,EKNOTS,FREQ
      COMMON /EPHEMS/ ORBINC,ERAD,IEPDAY,INCREM,INTRVL
      COMMON /FILTOP/ IMETH,ISPEC,IBTBS,SIGMLT,NFLAGK
      COMMON /LIMITS/ DXOL,DYOL,DZOL,DBOL,XWINDO,YWINDO,ZWINDO,BWINDO,
     *                ABVLAT,TRNLAT,ITMGAP
C
C COMMON REGION BSHARE COMMUNICATES BSPLYN SUBPROGRAM INFORMATION TO
C DTREND FOR INTERPOLATION PURPOSES AND SPECT FOR SPECTRAL ANALYSES
C
      COMMON /BSHARE/ TS,TF,EKN,FRQ,BSPLX,BSPLY,SIGCOM,V,COEF,D,WTRMS,
     *                GSIG,RESID
      DATA CLABEL /'X','Y','Z'/
C
C INITIALIZE ARRAY ICLASS FOR CLASSIFICATION COUNTS IN THIS INTERVAL
C
      DO 1 INTROW=1,3
      DO 1 INTCOL=1,8
    1 ICLASS(INTROW,INTCOL)=0
C
C REWIND FILTER INPUT UNIT IOR, IF OPERATION MODES 0 OR 3 ARE USED, THEN
C IOR = IST4
C
```

```
      REWIND IOR
C
C SET STEP4 SCRATCH UNITS TO ISC1 AND ISC2. OUTPUT SCRATCH UNIT ISC3
C STORES DATA QUALITY INFORMATION TO BE PLOTTED
C
      IWS=ISC1
      IRS=ISC2
      IWP=ISC3
C
C REWIND THE STEP4 SCRATCH UNITS
C
      REWIND IWS
      REWIND IRS
      REWIND IWP
C
C DECODE THE DATA QUALITY RETENTION CODE NFLAGK FOR THE FILTER. STORE
C EACH DIGIT OF THE CODE IN ARRAY KEEPDQ INDICATING DATA FLAG NUMBERS
C TO BE USED IN TREND FITTING. NFKEEP COUNTS NUMBER OF FLAGS TO BE
C RETAINED. IKEEP6 RECORDS RETENTION STATUS FOR INOTE = 6 DATA:
C
C IKEEP6 = 0 -->  INOTE = 6 DATA WILL BE OMITTED
C IKEEP6 = 1 -->  INOTE = 6 DATA WILL BE RETAINED
C
      IKEEP6=0
      NFKEEP=0
C
C STORE RIGHT-MOST DIGIT IN NUMK AND THEN REDUCE NFLAGK
C
    5 NUMK=MOD(NFLAGK,10)
      IF(NUMK.EQ.6) IKEEP6=1
      NFLAGK=NFLAGK/10
      NFKEEP=NFKEEP+1
C
C PLACE NUMK IN ELEMENT NUMBER NFKEEP OF ARRAY KEEPDQ
C
      KEEPDQ(NFKEEP)=NUMK
C
C IF NFLAGK HAS BEEN COMPLETELY DECODED, THEN EXIT THIS PROCESS
C
      IF(NFLAGK.EQ.0) GO TO 10
      GO TO 5
C
C COUNTER DEFINITIONS:
C
C NREAD IS TOTAL NUMBER OF POINTS READ BY THE FILTER
C I     IS CURRENT NUMBER OF DATA POINTS FOUND WITHIN TIME INTERVAL OF
C       INTEREST
C J     IS CURRENT NUMBER OF DATA POINTS READ THROUGH THE END OF THE
C       INTERVAL OF INTEREST
C K     IS CURRENT NUMBER OF DATA POINTS WHICH WILL BE USED IN THE TREND
C       FITTING PROCESS
C L     IS CURRENT NUMBER OF DATA POINTS WHICH WILL BE FILTERED
C
   10 NREAD=0
      I=0
      J=0
      K=0
      L=0
C
C BEGIN FILTERING INPUT DATA SET FROM UNIT IOR
```

```
C
   15 J=J+1
   20 READ(IOR,100,END=50) IYR,IDAY,IETIME,GLAT,GCLAT,GLON,GMLAT,GMLON,
     *ALT,CALT,BX,BY,BZ,BB,HX,HY,HZ,HB,TX,TY,TZ,TB,DX,DY,DZ,DB,CX,CY,CZ,
     *CB,IDIR,INOTE
  100 FORMAT(I2,I4,I6,7F7.2,20F8.1,2I5)
      NREAD=NREAD+1
C
C SETUP FOR DATA QUALITY CLASSIFICATION COUNTER ICLASS:
C
C ICLASS(1,II) -->  STATUS ON TOTAL IOR DATA SET AVAILABLE TO FILTER
C ICLASS(2,II) -->  STATUS ON ACTUAL INPUT DATA SET BEING FILTERED
C ICLASS(3,II) -->  STATUS ON ACTUAL DATA SET USED IN THE TREND FIT
C
C UPDATE QUALITY CLASSIFICATION COUNTS OF DATA SETS AS FOLLOWS:
C
C ICLASS(I,1) -->  COUNTS INOTE = 0
C ICLASS(I,2) -->  COUNTS INOTE = 1
C ICLASS(I,3) -->  COUNTS INOTE = 2
C ICLASS(I,4) -->  COUNTS INOTE = 3
C ICLASS(I,5) -->  COUNTS INOTE = 4
C ICLASS(I,6) -->  COUNTS INOTE = 5
C ICLASS(I,7) -->  COUNTS INOTE = 6
C ICLASS(I,8) -->  COUNTS INOTE = 7 (IDIR = 0)
C
C UPDATE QUALITY CLASSIFICATION COUNTS FOR ENTIRE UNIT IOR DATA SET
C
      ICLASS(1,INOTE+1)=ICLASS(1,INOTE+1)+1
C
C DETERMINE RELATIVE TIME OF DATA POINT (ICTIME) WITH RESPECT TO
C BEGINNING OF EPOCH DAY (IEPDAY), THEN DETERMINE ITS TIME INTERVAL (NI)
C WITH RESPECT TO INTERVAL WIDTH (INCREM). IF CURRENT DAY (IDAY) IS
C EARLIER THAN EPOCH DAY, THEN REJECT CURRENT POINT IMMEDIATELY
C
      IF(IDAY-IEPDAY.LT.0) GO TO 15
      ICTIME=(IDAY-IEPDAY)*86400+IETIME
      NI=INT(ICTIME/INCREM)+1
C
C COMPARE NI WITH TIME INTERVAL OF INTEREST (INTRVL)
C
      IF(NI-INTRVL) 15,25,20
   25 I=I+1
C
C IF NI MATCHES INTRVL, THEN EVALUATE POINT WITH RESPECT TO DATA QUALITY
C FLAGS DEFINED BELOW:
C
C INOTE = 0 -->  NO LIMITATIONS OR CONSTRAINTS ON DATA
C INOTE = 1 -->  GROSS-OUTLIER WITH RESPECT TO OBSERVED - COMPUTED FIELD
C INOTE = 2 -->  PADDED TIME-GAP VALUE
C INOTE = 3 -->  B-SPLINE FIT-OUTLIER
C INOTE = 4 -->  FOURIER FIT-OUTLIER
C INOTE = 5 -->  COMBINATION B-SPLINE/FOURIER FIT-OUTLIER
C INOTE = 6 -->  GEOCENTRIC LATITUDE OUTLIES TOLERANCE LEVEL ABVLAT
C INOTE = 7 -->  SATELLITE VELOCITY VECTOR DIRECTION IS INDETERMINABLE
C
C UPDATE QUALITY CLASSIFICATION COUNTS FOR THIS INTERVAL OF INTEREST
C
      ICLASS(2,INOTE+1)=ICLASS(2,INOTE+1)+1
C
C WRITE INFORMATION FOR ALL POINTS IN THIS INTERVAL TO SCRATCH UNIT IWP
```

```
C
      WRITE(IWP) GCLAT,IDIR,INOTE,I
C
C IF INOTE = 6, THEN BYPASS THIS CHECK AND EVALUATE AT NEXT CHECK
C
      IF(INOTE.EQ.6) GO TO 35
C
C CHECK DATA QUALITY FLAG INOTE AGAINST THE NFKEEP FLAGS TO BE RETAINED:
C
C IF INOTE MATCHES AN ELEMENT OF ARRAY KEEPDQ, THEN ACCEPT DATA POINT
C IF INOTE DOES NOT MATCH AN ELEMENT OF KEEPDQ, THEN REJECT DATA POINT
C
      DO 30 ICHECK=1,NFKEEP
   30 IF(INOTE.EQ.KEEPDQ(ICHECK)) GO TO 35
      GO TO 15
   35 L=L+1
C
C IF CURRENT POINT PASSES PREVIOUS EVALUATION, THEN IT WILL BE FILTERED
C CHECK IF GEOCENTRIC LATITUDE LIES WITHIN THE TOLERANCE LEVEL. FLAG
C POINTS WITH INOTE = 6 IF THE FOLLOWING CONDITIONS EXIST:
C
C GCLAT > +ABVLAT -->  POLAR DATA WITH GEOCENTRIC LATITUDE ABOVE +ABVLAT
C GCLAT < -ABVLAT -->  POLAR DATA WITH GEOCENTRIC LATITUDE BELOW -ABVLAT
C
      IF(ABS(GCLAT).GT.ABVLAT) INOTE=6
C
C WRITE OUT ON SCRATCH UNIT IWS INFORMATION WHICH MAY BE LATER MODIFIED.
C THIS INCLUDES POINTS THAT HAVE BEEN FLAGGED DUE TO GEOCENTRIC LATITUDE
C CONSTRAINTS, WHICH MAY BE EXCLUDED FROM THE TREND FIT
C
      WRITE(IWS) TX,TY,TZ,TB,INOTE,DX,DY,DZ,DB,I
C
C CHECK DATA QUALITY FLAG INOTE AGAINST THE NFKEEP FLAGS TO BE RETAINED:
C
      DO 40 ICHECK=1,NFKEEP
   40 IF(INOTE.EQ.KEEPDQ(ICHECK)) GO TO 45
      GO TO 15
C
C IF CURRENT POINT PASSES PREVIOUS EVALUATION, THEN IT WILL BE USED IN
C THE TREND FIT
C
   45 K=K+1
C
C UPDATE QUALITY CLASSIFICATION COUNTS FOR DATA USED IN TREND FIT
C
      ICLASS(3,INOTE+1)=ICLASS(3,INOTE+1)+1
C
C STORE CURRENT ABSCISSA IN ARRAY BSPLX FOR INPUT TO BSPLYN SUBPROGRAM
C
      BSPLX(K)=DBLE(I)
C
C DETERMINE THE LOWER (TS) AND UPPER (TF) LIMIT OF THE ABSCISSA INTERVAL
C
      IF(K.EQ.1) TS=BSPLX(K)
      IF(K.EQ.1) TF=TS
      IF(BSPLX(K).GT.TF) TF=BSPLX(K)
      GO TO 15
C
C WHEN ALL DATA IS READ FROM UNIT IOR, THEN REWIND IOR FOR MODIFICATION
C ALSO SWITCH STORAGE INPUT AND OUTPUT UNITS
```

```
C
   50 REWIND IOR
      CALL SWITCH(IWS,IRS)
C
C CALCULATE BEGINNING AND ENDING TIME IN DAYS AND SECONDS OF ARC
C SEGMENT TO BE FILTERED, THEN PRINT HEADING
C
      IBADD=(INTRVL-1)*INCREM
      IEADD=IBADD+INCREM
C
C CALCULATE BEGINNING (IBDY) AND ENDING (IEDY) DAYS
C
      IBDY=IEPDAY+INT(IBADD/86400)
      IEDY=IEPDAY+INT(IEADD/86400)
C
C CALCULATE BEGINNING (IBSC) AND ENDING (IESC) SECONDS
C
      IBSC=MOD(IBADD,86400)
      IESC=MOD(IEADD,86400)
      WRITE(6,101) IBDY,IBSC,IEDY,IESC
  101 FORMAT('1','*****************************************************
     ******************************************************************'
     */1X,'**** S T E P 4   F I L T E R   A R C   S E G M E N T   F R O
     *M :  ',I3,' DAYS ',I5,' SECS   T O :  ',I3,' DAYS ',I5,' SECS ****
     *'/1X,'**********************************************************
     ****************************************************************'//)
C
C PRINT QUALITY CLASSIFICATION STATUS OF INPUT DATA SET ON UNIT IOR
C
      WRITE(6,102)
  102 FORMAT(//1X,'<CLASSIFICATION OF INPUT DATA AVAILABLE FOR FILTERING
     *>')
      WRITE(6,103) (ICLASS(1,ICL),ICL=1,8),NREAD
  103 FORMAT(/6X,'FLAG',4X,'COUNT',27X,'DESCRIPTION'//1X,'INOTE = 0',4X,
     *I5,' -->  NO LIMITATIONS OR CONSTRAINTS'/1X,'INOTE = 1',4X,I5,' --
     *>  GROSS-OUTLIER WITH RESPECT TO OBSERVED - COMPUTED FIELD'/1X,'IN
     *OTE = 2',4X,I5,' -->  PADDED TIME-GAP VALUE'/1X,'INOTE = 3',4X,I5,
     *' -->  B-SPLINE FIT-OUTLIER'/1X,'INOTE = 4',4X,I5,' -->  FOURIER F
     *IT-OUTLIER'/1X,'INOTE = 5',4X,I5,' -->  COMBINATION B-SPLINE/FOURI
     *ER FIT-OUTLIER'/1X,'INOTE = 6',4X,I5,' -->  GEOCENTRIC LATITUDE LI
     *ES OUTSIDE TOLERANCE LEVEL'/1X,'INOTE = 7',4X,I5,' -->  SATELLITE
     *VELOCITY VECTOR DIRECTION IS INDETERMINABLE'//1X,'TOTAL ====>  ',I
     *5,' RECORDS   (EACH RECORD HAS 4 COMPONENTS: X, Y, Z, AND B)'//)
C
C IF NO POINTS ARE FOUND WITHIN THE INTERVAL OF INTEREST, THEN TERMINATE
C
      IF(I.EQ.0) WRITE(6,104) INTRVL
  104 FORMAT(//1X,'**** ATTENTION: NO POINTS WERE FOUND WITHIN INTERVAL
     *NUMBER: ',I3,' ****')
      IF(I.EQ.0) RETURN 2
C
C PRINT QUALITY CLASSIFICATION STATUS FOR THIS INTERVAL OF INTEREST
C
      WRITE(6,105)
  105 FORMAT(//1X,'<FILTER INPUT DATA CLASSIFICATION>')
      WRITE(6,103) (ICLASS(2,ICL),ICL=1,8),I
C
C PRINT QUALITY CLASSIFICATION STATUS FOR DATA SET USED IN TREND FIT
C
      WRITE(6,106)
```

```
  106 FORMAT(//1X,'<CLASSIFICATION OF DATA USED IN TREND FIT>')
      WRITE(6,103) (ICLASS(3,ICL),ICL=1,8),K
C
C PLOT VARIOUS DATA PARAMETERS
C
      CALL DPINFO(IWP,I)
C
C INDEPENDENTLY FILTER THE 3 TOPOCENTRIC FIELD COMPONENTS: IF LOOP = 1,
C THEN X; IF LOOP = 2, THEN Y; IF LOOP = 3, THEN Z
C
      DO 55 LOOP=1,3
      WRITE(6,107) CLABEL(LOOP)
  107 FORMAT('1','<FILTER TOPOCENTRIC ',A1,' COMPONENT>'//)
C
C READ FIELD COMPONENTS FROM IRS, STORE PROPER ORDINATE IN ARRAY BSPLY
C FOR INPUT TO BSPLYN SUBPROGRAM, THEN REWIND IRS FOR NEXT COMPONENT
C
      IV=0
      DO 60 II=1,L
      READ(IRS) TX,TY,TZ,TB,INOTE,DX,DY,DZ,DB,III
C
C IF GEOCENTRIC LATITUDE OF CURRENT POINT LIES OUTSIDE TOLERANCE LEVEL
C (INOTE = 6), THEN CHECK ITS TREND FIT RETENTION STATUS
C
      IF((INOTE.EQ.6).AND.(IKEEP6.EQ.0)) GO TO 60
      IV=IV+1
      IF(LOOP.EQ.1) BSPLY(IV)=DBLE(DX)
      IF(LOOP.EQ.2) BSPLY(IV)=DBLE(DY)
      IF(LOOP.EQ.3) BSPLY(IV)=DBLE(DZ)
   60 CONTINUE
      REWIND IRS
C
C TRANSFER PROPER INTERNAL KNOT INFORMATION TO ONE-DIMENSIONAL ARRAY
C EKN FOR INPUT TO BSPLYN
C
      KNOTF=0
      NKNOT=0
      DO 65 II=1,H(LOOP)
      AKNOT=DBLE(EKNOTS(LOOP,II))
C
C CHECK IF KNOT NUMBER II FOR THIS COMPONENT LIES WITHIN TIME DOMAIN
C (BETWEEN TS AND TF) OF THIS INTERVAL. IF IT DOES NOT, THEN OMIT THIS
C KNOT AND SET KNOTF = 1
C
      IF((AKNOT.LE.TS).OR.(AKNOT.GE.TF)) KNOTF=1
      IF((AKNOT.LE.TS).OR.(AKNOT.GE.TF)) GO TO 65
C
C IF KNOT LIES WITHIN TIME DOMAIN, THEN STORE IT IN THE NKNOT POSITION
C OF ARRAY EKN
C
      NKNOT=NKNOT+1
      EKN(NKNOT)=AKNOT
   65 CONTINUE
C
C IF KNOT SET HAS BEEN REDUCED (KNOTF = 1), THEN PRINT INDICATION
C
      IF(KNOTF.EQ.1) WRITE(6,108) NKNOT
  108 FORMAT(1X,'**** ATTENTION: KNOT SET HAS BEEN REDUCED TO ',I2,' KNO
     *TS TO CONFORM WITH DATA TIME CONSTRAINTS ****'//)
C
```

```
C TRANSFER PROPER A PRIORI FREQUENCY AND OBSERVATION SIGMA INFORMATION
C TO ONE-DIMENSIONAL ARRAYS FRQ AND SIGCOM, RESPECTIVELY, FOR BSPLYN
C
      DO 70 II=1,NT(LOOP)
   70 FRQ(II)=DBLE(FREQ(LOOP,II))
      DO 75 II=1,L
   75 SIGCOM(II)=DBLE(SIG(LOOP,II))
C
C FIT THE RESIDUAL DATA WITH A B-SPLINE AND/OR FOURIER WAVEFORMS USING
C THE BSPLYN SUBPROGRAM
C
      CALL BSPLYN(TS,TF,NN(LOOP),NKNOT,NT(LOOP),0,0,0,0,0,2,1,40,
     *KA(LOOP),ITERMX(LOOP),LGRMAX(LOOP),EPS(LOOP),K,KO(LOOP),EKN,FRQ,
     *BSPLX,BSPLY,SIGCOM,V,COEF,D,WTRMS,GSIG,RESID,0.D0)
C
C OPTION: PERFORM SPECTRAL ANALYSIS ON TREND FIT OF MAGNETIC COMPONENT
C
      IF(ISPEC.NE.0) CALL SPECT(LOOP,K,NKNOT)
C
C OPTION: FLAG POINTS WHOSE TREND RESIDUALS FALL OUTSIDE TOLERANCE LEVEL
C
      IF((IMETH.NE.0).AND.(IMETH.NE.3)) CALL OUTLIE(RESID,K,L,LOOP,IRS,
     *IWS)
C
C OPTION: DETREND INPUT MAGNETIC FIELD COMPONENTS
C
   55 IF((IMETH.NE.2).AND.(IMETH.NE.3)) CALL DTREND(LOOP,K,L,IRS,IWS,
     *NKNOT)
C
C WRITE OUT FILTERED DATA SET TO UNIT IOW
C
      CALL MODIFY(I,J,L,IRS,IWS)
      RETURN 1
      END
      SUBROUTINE SPECT(LOOP,K,NKNOT)
C
C SUBROUTINE TO PERFORM SPECTRAL ANALYSIS ON TREND FITS OF THE MAGNETIC
C FIELD COMPONENTS IN THE FREQUENCY DOMAIN USING A MIXED-RADIX FAST
C FOURIER TRANSFORM. ANALYSIS MAY BE DONE DIRECTLY OR WITH ZERO-MEAN
C ADJUSTMENT
C
      LOGICAL*1 IXFMT(7),IYFMT(7)
      INTEGER H(3)
      DIMENSION NN(3),NT(3),KA(3),ITERMX(3),LGRMAX(3),EPS(3),KO(3)
      DIMENSION EKNOTS(3,500),FREQ(3,500),SIG(3,500),AMP(500),PHI(500)
      DIMENSION POWER(500),PERIOD(500)
      REAL*8 BSPLX(500),BSPLY(500),V(5,500),COEF(500),D(13000)
      REAL*8 GSIG(5,500),EKN(500),FRQ(500),SIGCOM(500),RESID(500)
      REAL*8 Q(5,500),TS,TF,WTRMS,AREAL(500),AIMAG(500)
      COMMON /FILTOP/ IMETH,ISPEC,IBTBS,SIGMLT,NFLAGK
      COMMON /SPLINE/ H,NN,NT,KA,ITERMX,LGRMAX,EPS,KO,SIG,EKNOTS,FREQ
      COMMON /BSHARE/ TS,TF,EKN,FRQ,BSPLX,BSPLY,SIGCOM,V,COEF,D,WTRMS,
     *                GSIG,RESID
C
C SET DEGREES-TO-RADIANS CONVERSION
C
      DTR=3.141592653D0/180.D0
C
C DETERMINE TOTAL NUMBER OF INPUT DATA VALUES (NTOTL), ASSUMING A TIME
C INCREMENT OF ITMGAP SECONDS, OVER THE TIME SEGMENT FROM TS TO TF FIT
```

```
C BY THE TREND
C
      ITS=NINT(TS)
      ITF=NINT(TF)
      NTOTL=ITF-ITS+1
C
C SET FLAG FOR ODD (IEVEN = 0) OR EVEN (IEVEN = 1) NUMBER OF DATA POINTS
C
      IEVEN=0
      IF(MOD(NTOTL,2).EQ.0) IEVEN=1
C
C DETERMINE HALF-INTERVAL (IHALF) OF SYMMETRIC DATA INTERVAL (NTOTL)
C
      IHALF=NTOTL/2+1
C
C GENERATE AN ARRAY (AREAL) CONTAINING REAL COMPONENTS OF THE DATA AT
C EQUALLY SPACED TIME INTERVALS OF ITMGAP SECONDS OVER THE TIME SEGMENT
C FROM ITS TO ITF. IV IS CURRENT ELEMENT OF AREAL TO BE ASSIGNED AND IB
C IS CURRENT ELEMENT OF BSPLX AND COUNT OF NEXT TREND FIT VALUE TO BE
C ASSIGNED TO AREAL
C
      IV=0
      IB=1
      SUM=0.0
      DO 10 I=ITS,ITF
      IV=IV+1
C
C SET IMAGINARY COMPONENT OF INPUT DATA (AIMAG) TO ZERO
C
      AIMAG(IV)=0.D0
C
C DETERMINE WHETHER TREND FIT VALUE EXISTS AT CURRENT RELATIVE TIME I
C
      IF(I.EQ.NINT(BSPLX(IB))) GO TO 20
C
C IF CURRENT RELATIVE TIME VALUE I DOES NOT MATCH TIME VALUE OF NEXT
C TREND FIT POINT, THEN CALL SUBPROGRAM BSPLYN TO INTERPOLATE A TREND
C FIT VALUE AT TIME I, THEN ASSIGN THIS VALUE Q(1,1) TO CURRENT ELEMENT
C OF AREAL
C
      XINTRP=DBLE(I)
      CALL BSPLYN(TS,TF,NN(LOOP),NKNOT,NT(LOOP),0,0,0,1,0,2,1,40,
     *KA(LOOP),ITERMX(LOOP),LGRMAX(LOOP),EPS(LOOP),K,KO(LOOP),EKN,FRQ,
     *BSPLX,BSPLY,SIGCOM,Q,COEF,D,WTRMS,GSIG,RESID,XINTRP)
      AREAL(IV)=Q(1,1)
      GO TO 10
C
C IF CURRENT RELATIVE TIME VALUE I MATCHES TIME VALUE OF NEXT TREND FIT
C POINT (STORED IN ELEMENT IB OF BSPLX), THEN ASSIGN TREND FIT VALUE OF
C THAT POINT V(1,IB) TO CURRENT ELEMENT OF AREAL
C
   20 AREAL(IV)=V(1,IB)
      IB=IB+1
C
C SUM THE REAL COMPONENTS OF THE DATA
C
   10 SUM=SUM+REAL(AREAL(IV))
C
C IF ISPEC = 1, DETERMINE DATA MEAN AND SUBTRACT FROM REAL COMPONENTS
C IF ISPEC = 2, DO NOT DETERMINE OR SUBTRACT DATA MEAN
```

```
C
      IF(ISPEC.EQ.2) GO TO 30
      AMEAN=SUM/REAL(NTOTL)
      DO 40 IM=1,NTOTL
   40 AREAL(IM)=AREAL(IM)-AMEAN
C
C COMPUTE COMPLEX FOURIER TRANSFORM OF AN NTOTL NUMBER OF REAL, EQUALLY
C SPACED DATA COMPONENTS IN PLACE USING A MIXED-RADIX FAST FOURIER
C TRANSFORM. SUBPROGRAM FFT RETURNS REAL AND IMAGINARY COMPONENTS OF THE
C RESULTING FOURIER COEFFICIENTS IN AREAL AND AIMAG, RESPECTIVELY
C
   30 CALL FFT(AREAL,AIMAG,NTOTL,NTOTL,NTOTL,1)
C
C PRINT SPECTRAL ANALYSIS HEADINGS
C
      WRITE(6,100)
  100 FORMAT(//1X,'<SPECTRAL ANALYSIS OF TREND FIT>')
      IF(ISPEC.EQ.1) WRITE(6,101)
  101 FORMAT(/1X,'** THIS IS A ZERO-MEAN ANALYSIS **')
      IF(ISPEC.EQ.2) WRITE(6,102)
  102 FORMAT(/1X,'** THIS IS A DIRECT ANALYSIS **')
      WRITE(6,103)
  103 FORMAT(/1X,'NUM',8X,'PERIOD',16X,'AMPLITUDE',20X,'PHASE',20X,'POWE
     *R'/)
C
C CALCULATE VARIOUS SPECTRA ONLY IN POSITIVE FREQUENCY DOMAIN DUE TO
C SYMMETRY CONSIDERATIONS
C
      DO 50 IK=2,IHALF
      IKM1=IK-1
C
C CALCULATE POWER SPECTRUM
C
      POWER(IKM1)=REAL(2.D0*(AREAL(IK)**2+AIMAG(IK)**2))
C
C CALCULATE PHASE SPECTRUM
C
      PHI(IKM1)=REAL(DATAN2(AIMAG(IK),AREAL(IK))/DTR)
C
C CALCULATE AMPLITUDE SPECTRUM
C
      AMP(IKM1)=REAL(DSQRT(AREAL(IK)**2+AIMAG(IK)**2))
C
C IF EVEN NUMBER OF DATA POINTS WERE ANALYZED, THEN HIGHEST FREQUENCY
C AMPLITUDE IS EQUALLY DISTRIBUTED OVER ITS CORRESPONDING POSITIVE AND
C NEGATIVE FREQUENCIES
C
      IF((IK.EQ.IHALF).AND.(IEVEN.EQ.1)) AMP(IKM1)=AMP(IKM1)/2.0
C
C CALCULATE PERIODS CORRESPONDING TO FOURIER FREQUENCIES
C
      PERIOD(IKM1)=REAL(NTOTL)/REAL(IK-1)
C
C PRINT FREQUENCY NUMBER, CORRESPONDING PERIOD, AND VARIOUS SPECTRA
C
   50 WRITE(6,104) IKM1,PERIOD(IKM1),AMP(IKM1),PHI(IKM1),POWER(IKM1)
  104 FORMAT(1X,I3,4X,F10.5,3F25.5)
C
C PLOT VARIOUS SPECTRA
C
```

```
      LTOTL=IHALF-1
C
C INITIALIZE PRINTER PLOTTING
C
      CALL PLOTST(00001,1)
C
C DETERMINE MINIMUM AND MAXIMUM VALUES FOR PERIOD
C
      CALL MAXMIN(PERIOD,LTOTL,XMIN,XMAX)
C
C DETERMINE PLOTTING FORMAT FOR PERIOD
C
      CALL FORMAT(XMIN,XMAX,IXFMT)
C
C IF NPLT = 1, PLOT AMPLITUDE SPECTRUM ON LOG VERSUS LOG GRID
C IF NPLT = 2, PLOT PHASE SPECTRUM ON LINEAR VERSUS LOG GRID
C IF NPLT = 3, PLOT POWER SPECTRUM ON LOG VERSUS LOG GRID
C
      DO 60 NPLT=1,3
C
C DETERMINE MINIMUM AND MAXIMUM VALUES FOR AMPLITUDE, PHASE, AND POWER
C DETERMINE FORMAT OF ORDINATE FOR PHASE PLOT
C
      IF(NPLT.EQ.1) CALL MAXMIN(AMP,LTOTL,YMIN,YMAX)
      IF(NPLT.EQ.2) CALL GRDNUM(PHI,LTOTL,YMIN,YMAX,KINT,IYFMT)
      IF(NPLT.EQ.3) CALL MAXMIN(POWER,LTOTL,YMIN,YMAX)
C
C DETERMINE FORMAT OF ORDINATE FOR AMPLITUDE AND POWER PLOTS
C
      IF(NPLT.NE.2) CALL FORMAT(YMIN,YMAX,IYFMT)
C
C DEFINE CARTESIAN OBJECT SPACE FOR PLOTS
C
      CALL SETGRD(11.0,12.0,123.0,65.0,1)
C
C IF PLOTTING:
C
C AMPLITUDE -->  OVERLAY CARTESIAN LOG-LOG GRID WITH TICK MARKS
C PHASE     -->  OVERLAY CARTESIAN SEMI-LOG GRID WITH TICK MARKS
C POWER     -->  OVERLAY CARTESIAN LOG-LOG GRID WITH TICK MARKS
C
      IF(NPLT.EQ.2) CALL OGRID(XMIN,XMAX,9,IXFMT,2,YMIN,YMAX,KINT,IYFMT,
     *2,1)
      IF(NPLT.NE.2) CALL OGRID(XMIN,XMAX,9,IXFMT,2,YMIN,YMAX,9,IYFMT,
     *2,3)
C
C PLOT AMPLITUDE, PHASE, AND POWER SPECTRA
C
      IF(NPLT.EQ.1) CALL PLOT(PERIOD,AMP,LTOTL,' ')
      IF(NPLT.EQ.2) CALL PLOT(PERIOD,PHI,LTOTL,' ')
      IF(NPLT.EQ.3) CALL PLOT(PERIOD,POWER,LTOTL,' ')
C
C PRINT HEADING
C
      IF(NPLT.EQ.1) CALL HORLIN('AMPLITUDE SPECTRUM (LOG VS. LOG)',32,
     *66.0,67.0,0,0)
      IF(NPLT.EQ.2) CALL HORLIN('PHASE SPECTRUM (LINEAR VS. LOG)',31,
     *66.0,67.0,0,0)
      IF(NPLT.EQ.3) CALL HORLIN('POWER SPECTRUM (LOG VS. LOG)',28,
     *66.0,67.0,0,0)
```

```
C
C LABEL INDEPENDENT AXIS
C
      CALL HORLIN('PERIOD',6,66.0,8.0,0,0)
   60 IF(NPLT.LE.2) CALL FRMADV
C
C TERMINATE PLOTTING SEQUENCE
C
      CALL ENDPLT
      RETURN
      END
      SUBROUTINE FFT(A,B,NTOT,N,NSPAN,ISN)
C  MULTIVARIATE COMPLEX FOURIER TRANSFORM, COMPUTED IN PLACE
C    USING MIXED-RADIX FAST FOURIER TRANSFORM ALGORITHM.
C  BY R. C. SINGLETON, STANFORD RESEARCH INSTITUTE, OCT. 1968
C  ARRAYS A AND B ORIGINALLY HOLD THE REAL AND IMAGINARY
C    COMPONENTS OF THE DATA, AND RETURN THE REAL AND
C    IMAGINARY COMPONENTS OF THE RESULTING FOURIER COEFFICIENTS.
C  MULTIVARIATE DATA IS INDEXED ACCORDING TO THE FORTRAN
C    ARRAY ELEMENT SUCCESSOR FUNCTION, WITHOUT LIMIT
C    ON THE NUMBER OF IMPLIED MULTIPLE SUBSCRIPTS.
C    THE SUBROUTINE IS CALLED ONCE FOR EACH VARIATE.
C    THE CALLS FOR A MULTIVARIATE TRANSFORM MAY BE IN ANY ORDER.
C  NTOT IS THE TOTAL NUMBER OF COMPLEX DATA VALUES.
C  N IS THE DIMENSION OF THE CURRENT VARIABLE.
C  NSPAN/N IS THE SPACING OF CONSECUTIVE DATA VALUES
C    WHILE INDEXING THE CURRENT VARIABLE.
C  THE SIGN OF ISN DETERMINES THE SIGN OF THE COMPLEX
C    EXPONENTIAL, AND THE MAGNITUDE OF ISN IS NORMALLY ONE.
C  A TRI-VARIATE TRANSFORM WITH A(N1,N2,N3), B(N1,N2,N3)
C    IS COMPUTED BY
C      CALL FFT(A,B,N1*N2*N3,N1,N1,1)
C      CALL FFT(A,B,N1*N2*N3,N2,N1*N2,1)
C      CALL FFT(A,B,N1*N2*N3,N3,N1*N2*N3,1)
C  FOR A SINGLE-VARIATE TRANSFORM,
C    NTOT = N = NSPAN = (NUMBER OF COMPLEX DATA VALUES), E.G.
C      CALL FFT(A,B,N,N,N,1)
C  THE DATA MAY ALTERNATIVELY BE STORED IN A SINGLE COMPLEX
C    ARRAY A, THEN THE MAGNITUDE OF ISN CHANGED TO TWO TO
C    GIVE THE CORRECT INDEXING INCREMENT AND A(2) USED TO
C    PASS THE INITIAL ADDRESS FOR THE SEQUENCE OF IMAGINARY
C    VALUES, E.G.
C      CALL FFT(A,A(2),NTOT,N,NSPAN,2)
C  ARRAYS AT(MAXF), CK(MAXF), BT(MAXF), SK(MAXF), AND NP(MAXP)
C    ARE USED FOR TEMPORARY STORAGE.  IF THE AVAILABLE STORAGE
C    IS INSUFFICIENT, THE PROGRAM IS TERMINATED BY A STOP.
C   *** TO CONVERT PROGRAM TO DOUBLE PRECISION, REMOVE C FROM
C          FOLLOWING STATEMENTS
      DOUBLE PRECISION A,B,AA,BB,AJ,BJ,AK,BK,AT,BT,AJM,BJM,AKM,BKM
      DOUBLE PRECISION AJP,BJP,AKP,BKP,C1,C2,C3,S1,S2,S3,CD,SD,CK,SK
      DOUBLE PRECISION S72,C72,S120,RAD,RADF,ZERO,HALF,ONE,TWO,FIVE
C    MAXF MUST BE .GE. THE MAXIMUM PRIME FACTOR OF N.
C    MAXP MUST BE .GT. THE NUMBER OF PRIME FACTORS OF N.
C    IN ADDITION, IF THE SQUARE-FREE PORTION K CF N HAS TWO OR
C    MORE PRIME FACTORS, THEN MAXP MUST BE .GE. K-1.
      DIMENSION A(1),B(1)
C  ARRAY STORAGE IN NFAC FOR A MAXIMUM OF 20 FACTORS OF N.
C  IF N HAS MORE THAN ONE SQUARE-FREE FACTOR, THE PRODUCT OF THE
C    SQUARE-FREE FACTORS MUST BE .LE. 502
      DIMENSION NFAC(20),NP(501)
```

```
C  ARRAY STORAGE FOR MAXIMUM PRIME FACTOR OF 501
      DIMENSION AT(501),CK(501),BT(501),SK(501)
      EQUIVALENCE (I,II)
      SIN(AA)=DSIN(AA)
      COS(AA)=DCOS(AA)
      FLOAT(I)=DFLOAT(I)
C  THE FOLLOWING TWO CONSTANTS SHOULD AGREE WITH THE ARRAY DIMENSIONS.
      MAXF=501
      MAXP=501
      IF(N.LT.2)RETURN
      INC=ISN
      RAD=6.28318530717958647692528676655900576
      S72=RAD/5.0
      C72=COS(S72)
      S72=SIN(S72)
C         S120=SQRT(3)/2
      S120=0.86602540378443864676372317075293618
      IF(ISN.GE.0)GO TO 10
      S72=-S72
      S120=-S120
      RAD=-RAD
      INC=-INC
   10 NT=INC*NTOT
      KS=INC*NSPAN
      KSPAN=KS
      NN=NT-INC
      JC=KS/N
      RADF=RAD*FLOAT(JC)*0.5
      I=0
      JF=0
C  DETERMINE THE FACTORS OF N
      M=0
      K=N
      GO TO 20
   15 M=M+1
      NFAC(M)=4
      K=K/16
   20 IF(K-(K/16)*16 .EQ. 0) GO TO 15
      J=3
      JJ=9
      GO TO 30
   25 M=M+1
      NFAC(M)=J
      K=K/JJ
   30 IF(MOD(K,JJ) .EQ. 0) GO TO 25
      J=J+2
      JJ=J**2
      IF(JJ .LE. K) GO TO 30
      IF(K .GT. 4) GO TO 40
      KT=M
      NFAC(M+1)=K
      IF(K .NE.1) M=M+1
      GO TO 80
   40 IF(K-(K/4)*4 .NE. 0) GO TO 50
      M=M+1
      NFAC(M)=2
      K=K/4
   50 KT=M
      J=2
   60 IF(MOD(K,J) .NE. 0) GO TO 70
```

```
      M=M+1
      NFAC(M)=J
      K=K/J
   70 J=((J+1)/2)*2+1
      IF(J .LE. K) GO TO 60
   80 IF(KT .EQ. 0) GO TO 100
      J=KT
   90 M=M+1
      NFAC(M)=NFAC(J)
      J=J-1
      IF(J .NE. 0) GO TO 90
C  COMPUTE FOURIER TRANSFORM
  100 SD=RADF/FLOAT(KSPAN)
      CD=2.0*SIN(SD)**2
      SD=SIN(SD+SD)
      KK=1
      I=I+1
      IF(NFAC(I) .NE. 2) GO TO 400
C  TRANSFORM FOR FACTOR OF 2 (INCLUDING ROTATION FACTOR)
      KSPAN=KSPAN/2
      K1=KSPAN+2
  210 K2=KK+KSPAN
      AK=A(K2)
      BK=B(K2)
      A(K2)=A(KK)-AK
      B(K2)=B(KK)-BK
      A(KK)=A(KK)+AK
      B(KK)=B(KK)+BK
      KK=K2+KSPAN
      IF(KK .LE. NN) GO TO 210
      KK=KK-NN
      IF(KK .LE. JC) GO TO 210
      IF(KK .GT. KSPAN) GO TO 800
  220 C1=1.0-CD
      S1=SD
  230 K2=KK+KSPAN
      AK=A(KK)-A(K2)
      BK=B(KK)-B(K2)
      A(KK)=A(KK)+A(K2)
      B(KK)=B(KK)+B(K2)
      A(K2)=C1*AK-S1*BK
      B(K2)=S1*AK+C1*BK
      KK=K2+KSPAN
      IF(KK .LT. NT) GO TO 230
      K2=KK-NT
      C1=-C1
      KK=K1-K2
      IF(KK .GT. K2) GO TO 230
      AK=C1-(CD*C1+SD*S1)
      S1=(SD*C1-CD*S1)+S1
C  THE FOLLOWING THREE STATEMENTS COMPENSATE FOR TRUNCATION
C     ERROR. IF ROUNDED ARITHMETIC IS USED, SUBSTITUE
C       C1=AK
      C1=0.5/(AK**2+S1**2)+0.5
      S1=C1*S1
      C1=C1*AK
      KK=KK+JC
      IF(KK .LT. K2) GO TO 230
      K1=K1+INC+INC
      KK=(K1-KSPAN)/2+JC
```

```
      IF(KK .LE. JC+JC) GO TO 220
      GO TO 100
C  TRANSFORM FOR FACTOR OF 3 (OPTIONAL CODE)
  320 K1=KK+KSPAN
      K2=K1+KSPAN
      AK=A(KK)
      BK=B(KK)
      AJ=A(K1)+A(K2)
      BJ=B(K1)+B(K2)
      A(KK)=AK+AJ
      B(KK)=BK+BJ
      AK=-0.5*AJ+AK
      BK=-0.5*BJ+BK
      AJ=(A(K1)-A(K2))*S120
      BJ=(B(K1)-B(K2))*S120
      A(K1)=AK-BJ
      B(K1)=BK+AJ
      A(K2)=AK+BJ
      B(K2)=BK-AJ
      KK=K2+KSPAN
      IF(KK .LT. NN) GO TO 320
      KK=KK-NN
      IF(KK .LE. KSPAN) GO TO 320
      GO TO 700
C  TRANSFORM FOR FACTOR OF 4
  400 IF(NFAC(I) .NE. 4) GO TO 600
      KSPNN=KSPAN
      KSPAN=KSPAN/4
  410 C1=1.0
      S1=0.
  420 K1=KK+KSPAN
      K2=K1+KSPAN
      K3=K2+KSPAN
      AKP=A(KK)+A(K2)
      AKM=A(KK)-A(K2)
      AJP=A(K1)+A(K3)
      AJM=A(K1)-A(K3)
      A(KK)=AKP+AJP
      AJP=AKP-AJP
      BKP=B(KK)+B(K2)
      BKM=B(KK)-B(K2)
      BJP=B(K1)+B(K3)
      BJM=B(K1)-B(K3)
      B(KK)=BKP+BJP
      BJP=BKP-BJP
      IF(ISN .LT. 0) GO TO 450
      AKP=AKM-BJM
      AKM=AKM+BJM
      BKP=BKM+AJM
      BKM=BKM-AJM
      IF(S1 .EQ. 0.0) GO TO 460
  430 A(K1)=AKP*C1-BKP*S1
      B(K1)=AKP*S1+BKP*C1
      A(K2)=AJP*C2-BJP*S2
      B(K2)=AJP*S2+BJP*C2
      A(K3)=AKM*C3-BKM*S3
      B(K3)=AKM*S3+BKM*C3
      KK=K3+KSPAN
      IF(KK .LE. NT) GO TO 420
  440 C2=C1-(CD*C1+SD*S1)
```

```
      S1=(SD*C1-CD*S1)+S1
C  THE FOLLOWING THREE STATEMENTS COMPENSATE FOR TRUNCATION
C     ERROR. IF ROUNDED ARITHMETIC IS USED, SUBSTITUTE
C      C1=C2
      C1=0.5/(C2**2+S1**2)+0.5
      S1=C1*S1
      C1=C1*C2
      C2=C1**2-S1**2
      S2=2.0*C1*S1
      C3=C2*C1-S2*S1
      S3=C2*S1+S2*C1
      KK=KK-NT+JC
      IF(KK .LE.KSPAN) GO TO 420
      KK=KK-KSPAN+INC
      IF(KK .LE. JC) GO TO 410
      IF(KSPAN .EQ. JC) GO TO 800
      GO TO 100
  450 AKP=AKM+BJM
      AKM=AKM-BJM
      BKP=BKM-AJM
      BKM=BKM+AJM
      IF(S1 .NE. 0.0) GO TO 430
  460 A(K1)=AKP
      B(K1)=BKP
      A(K2)=AJP
      B(K2)=BJP
      A(K3)=AKM
      B(K3)=BKM
      KK=K3+KSPAN
      IF(KK .LE. NT) GO TO 420
      GO TO 440
C  TRANSFORM FOR FACTOR OF 5 (OPTIONAL CODE)
  510 C2=C72**2-S72**2
      S2=2.0*C72*S72
  520 K1=KK+KSPAN
      K2=K1+KSPAN
      K3=K2+KSPAN
      K4=K3+KSPAN
      AKP=A(K1)+A(K4)
      AKM=A(K1)-A(K4)
      BKP=B(K1)+B(K4)
      BKM=B(K1)-B(K4)
      AJP=A(K2)+A(K3)
      AJM=A(K2)-A(K3)
      BJP=B(K2)+B(K3)
      BJM=B(K2)-B(K3)
      AA=A(KK)
      BB=B(KK)
      A(KK)=AA+AKP+AJP
      B(KK)=BB+BKP+BJP
      AK=AKP*C72+AJP*C2+AA
      BK=BKP*C72+BJP*C2+BB
      AJ=AKM*S72+AJM*S2
      BJ=BKM*S72+BJM*S2
      A(K1)=AK-BJ
      A(K4)=AK+BJ
      B(K1)=BK+AJ
      B(K4)=BK-AJ
      AK=AKP*C2+AJP*C72+AA
      BK=BKP*C2+BJP*C72+BB
```

```
      AJ=AKM*S2-AJM*S72
      BJ=BKM*S2-BJM*S72
      A(K2)=AK-BJ
      A(K3)=AK+BJ
      B(K2)=BK+AJ
      B(K3)=BK-AJ
      KK=K4+KSPAN
      IF(KK .LT. NN) GO TO 520
      KK=KK-NN
      IF(KK .LE. KSPAN) GO TO 520
      GO TO 700
C  TRANSFORM FOR ODD FACTORS
  600 K=NFAC(I)
      KSPNN=KSPAN
      KSPAN=KSPAN/K
      IF(K .EQ. 3) GO TO 320
      IF(K .EQ. 5) GO TO 510
      IF(K .EQ. JF) GO TO 640
      JF=K
      S1=RAD/FLOAT(K)
      C1=COS(S1)
      S1=SIN(S1)
      IF(JF .GT. MAXF) GO TO 998
      CK(JF)=1.0
      SK(JF)=0.0
      J=1
  630 CK(J)=CK(K)*C1+SK(K)*S1
      SK(J)=CK(K)*S1-SK(K)*C1
      K=K-1
      CK(K)=CK(J)
      SK(K)=-SK(J)
      J=J+1
      IF(J .LT. K) GO TO 630
  640 K1=KK
      K2=KK+KSPNN
      AA=A(KK)
      BB=B(KK)
      AK=AA
      BK=BB
      J=1
      K1=K1+KSPAN
  650 K2=K2-KSPAN
      J=J+1
      AT(J)=A(K1)+A(K2)
      AK=AT(J)+AK
      BT(J)=B(K1)+B(K2)
      BK=BT(J)+BK
      J=J+1
      AT(J)=A(K1)-A(K2)
      BT(J)=B(K1)-B(K2)
      K1=K1+KSPAN
      IF(K1 .LT. K2) GO TO 650
      A(KK)=AK
      B(KK)=BK
      K1=KK
      K2=KK+KSPNN
      J=1
  660 K1=K1+KSPAN
      K2=K2-KSPAN
      JJ=J
```

```
      AK=AA
      BK=BB
      AJ=0.0
      BJ=0.0
      K=1
  670 K=K+1
      AK=AT(K)*CK(JJ)+AK
      BK=BT(K)*CK(JJ)+BK
      K=K+1
      AJ=AT(K)*SK(JJ)+AJ
      BJ=BT(K)*SK(JJ)+BJ
      JJ=JJ+J
      IF(JJ .GT. JF) JJ=JJ-JF
      IF(K .LT. JF) GO TO 670
      K=JF-J
      A(K1)=AK-BJ
      B(K1)=BK+AJ
      A(K2)=AK+BJ
      B(K2)=BK-AJ
      J=J+1
      IF(J .LT. K) GO TO 660
      KK=KK+KSPNN
      IF(KK .LE. NN) GO TO 640
      KK=KK-NN
      IF(KK .LE. KSPAN) GO TO 640
C  MULTIPLY BY ROTATION FACTOR (EXCEPT FOR FACTORS OF 2 AND 4)
  700 IF(I .EQ. M) GO TO 800
      KK=JC+1
  710 C2=1.0-CD
      S1=SD
  720 C1=C2
      S2=S1
      KK=KK+KSPAN
  730 AK=A(KK)
      A(KK)=C2*AK-S2*B(KK)
      B(KK)=S2*AK+C2*B(KK)
      KK=KK+KSPNN
      IF(KK .LE. NT) GO TO 730
      AK=S1*S2
      S2=S1*C2+C1*S2
      C2=C1*C2-AK
      KK=KK-NT+KSPAN
      IF(KK .LE. KSPNN) GO TO 730
      C2=C1-(CD*C1+SD*S1)
      S1=S1+(SD*C1-CD*S1)
C  THE FOLLOWING THREE STATEMENTS COMPENSATE FOR TRUNCATION
C    ERROR. IF ROUNDED ARITHMETIC USED, THEY MAY
C    BE DELETED.
      C1=0.5/(C2**2+S1**2)+0.5
      S1=C1*S1
      C2=C1*C2
      KK=KK-KSPNN+JC
      IF(KK .LE. KSPAN) GO TO 720
      KK=KK-KSPAN+JC+INC
      IF(KK .LE. JC+JC) GO TO 710
      GO TO 100
C  PERMUTE THE RESULTS TO NORMAL ORDER---DONE IN TWO STAGES
C  PERMUATION FOR SQUARE FACTORS OF N
  800 NP(1)=KS
      IF(KT .EQ. 0) GO TO 890
```

```
      K=KT+KT+1
      IF(M .LT. K) K=K-1
      J=1
      NP(K+1)=JC
  810 NP(J+1)=NP(J)/NFAC(J)
      NP(K)=NP(K+1)*NFAC(J)
      J=J+1
      K=K-1
      IF(J .LT. K) GO TO 810
      K3=NP(K+1)
      KSPAN=NP(2)
      KK=JC+1
      K2=KSPAN+1
      J=1
      IF(N .NE. NTOT) GO TO 850
C  PERMUTATION FOR SINGLE-VARIATE TRANSFORM (OPTIONAL CODE)
  820 AK=A(KK)
      A(KK)=A(K2)
      A(K2)=AK
      BK=B(KK)
      B(KK)=B(K2)
      B(K2)=BK
      KK=KK+INC
      K2=KSPAN+K2
      IF(K2 .LT. KS) GO TO 820
  830 K2=K2-NP(J)
      J=J+1
      K2=NP(J+1)+K2
      IF(K2 .GT. NP(J)) GO TO 830
      J=1
  840 IF(KK .LT. K2) GO TO 820
      KK=KK+INC
      K2=KSPAN+K2
      IF(K2 .LT. KS) GO TO 840
      IF(KK .LT. KS) GO TO 830
      JC=K3
      GO TO 890
C  PERMUATION FOR MULTIVARIATE TRANSFORM
  850 K=KK+JC
  860 AK=A(KK)
      A(KK)=A(K2)
      A(K2)=AK
      BK=B(KK)
      B(KK)=B(K2)
      B(K2)=BK
      KK=KK+INC
      K2=K2+INC
      IF(KK .LT. K) GO TO 860
      KK=KK+KS-JC
      K2=K2+KS-JC
      IF(KK .LT. NT) GO TO 850
      K2=K2-NT+KSPAN
      KK=KK-NT+JC
      IF(K2 .LT. KS) GO TO 850
  870 K2=K2-NP(J)
      J=J+1
      K2=NP(J+1)+K2
      IF(K2 .GT. NP(J)) GO TO 870
      J=1
  880 IF(KK .LT. K2) GO TO 850
```

```
      KK=KK+JC
      K2=KSPAN+K2
      IF(K2 .LT. KS) GO TO 880
      IF(KK .LT. KS) GO TO 870
      JC=K3
  890 IF(2*KT+1 .GE. M) RETURN
      KSPNN=NP(KT+1)
C  PERMUTATION FOR SQUARE-FREE FACTORS OF N
      J=M-KT
      NFAC(J+1)=1
  900 NFAC(J)=NFAC(J)*NFAC(J+1)
      J=J-1
      IF(J .NE. KT) GO TO 900
      KT=KT+1
      NN=NFAC(KT)-1
      IF(NN .GT. MAXP) GO TO 998
      JJ=0
      J=0
      GO TO 906
  902 JJ=JJ-K2
      K2=KK
      K=K+1
      KK=NFAC(K)
  904 JJ=KK+JJ
      IF(JJ .GE. K2) GO TO 902
      NP(J)=JJ
  906 K2=NFAC(KT)
      K=KT+1
      KK=NFAC(K)
      J=J+1
      IF(J .LE. NN)GO TO 904
C  DETERMINE THE PERMUATION CYCLES OF LENGTH GREATER THAN 1
      J=0
      GO TO 914
  910 K=KK
      KK=NP(K)
      NP(K)=-KK
      IF(KK .NE. J) GO TO 910
      K3=KK
  914 J=J+1
      KK=NP(J)
      IF(KK .LT. 0) GO TO 914
      IF(KK .NE. J) GO TO 910
      NP(J)=-J
      IF(J .NE. NN) GO TO 914
      MAXF=INC*MAXF
C  REORDER A AND B, FOLLOWING THE PERMUTATION CYCLES
      GO TO 950
  924 J=J-1
      IF(NP(J) .LT. 0) GO TO 924
      JJ=JC
  926 KSPAN=JJ
      IF(JJ .GT. MAXF) KSPAN=MAXF
      JJ=JJ-KSPAN
      K=NP(J)
      KK=JC*K+II+JJ
      K1=KK+KSPAN
      K2=0
  928 K2=K2+1
      AT(K2)=A(K1)
```

```
      BT(K2)=B(K1)
      K1=K1-INC
      IF(K1 .NE. KK) GO TO 928
  932 K1=KK+KSPAN
      K2=K1-JC*(K+NP(K))
      K=-NP(K)
  936 A(K1)=A(K2)
      B(K1)=B(K2)
      K1=K1-INC
      K2=K2-INC
      IF(K1 .NE. KK) GO TO 936
      KK=K2
      IF(K .NE. J) GO TO 932
      K1=KK+KSPAN
      K2=0
  940 K2=K2+1
      A(K1)=AT(K2)
      B(K1)=BT(K2)
      K1=K1-INC
      IF(K1 .NE. KK) GO TO 940
      IF(JJ .NE. 0) GO TO 926
      IF(J .NE. 1) GO TO 924
  950 J=K3+1
      NT=NT-KSPNN
      II=NT-INC+1
      IF(NT .GE. 0) GO TO 924
      RETURN
C  ERROR FINISH, INSUFFICIENT ARRAY STORAGE
  998 ISN=0
      PRINT 999
  999 FORMAT(44H0ARRAY BOUNDS EXCEEDED WITHIN SUBROUTINE FFT)
      RETURN
      END
      SUBROUTINE REALTR(A,B,N,ISN)
C  IF ISN=1, THIS SUBROUTINE COMPLETES THE FOURIER TRANSFORM
C    OF 2*N REAL DATA VALUES, WHERE THE ORIGINAL DATA VALUES ARE
C    STORED ALTERNATELY IN ARRAYS A AND B, AND ARE FIRST
C    TRANSFORMED BY A COMPLEX FOURIER TRANSFORM OF DIMENSION N.
C    THE COSINE COEFFICIENTS ARE IN A(1),A(2),...A(N+1) AND
C    THE SINE COEFFICIENTS ARE IN B(1),B(2),...B(N+1).
C    A TYPICAL CALLING SEQUENCE IS
C     CALL FFT(A,B,N,N,N,1)
C     CALL REALTR(A,B,N,1)
C    THE RESULTS SHOULD BE MULTIPLIED BY 0.5/N TO GIVE THE
C    USUAL SCALING OF COEFFICIENTS.
C  IF ISN=-1, THE INVERSE TRANSFORMATION IS DONE, THE FIRST STEP
C    IN EVALUATING A REAL FOURIER SERIES.
C    A TYPICAL CALLING SEQUENCE IS
C      CALL REALTR(A,B,N,-1)
C      CALL FFT(A,B,N,N,N,-1)
C    THE RESULTS SHOULD BE MULTIPLIED BY 0.5 TO GIVE THE USUAL
C    SCALING, AND THE TIME DOMAIN RESULTS ALTERNATE IN ARRAYS A
C    AND B, I.E. A(1),B(1),A(2),B(2),...A(N),B(N).
C  THE DATA MAY ALTERNATIVELY BE STORED IN A SINGLE COMPLEX
C    ARRAY A, THEN THE MAGNITUDE OF ISN CHANGED TO TWO TO
C    GIVE THE CORRECT INDEXING INCREMENT AND A(2) USED TO
C    PASS THE INITIAL ADDRESS FOR THE SEQUENCE OF IMAGINARY
C    VALUES, E.G.
C      CALL FFT(A,A(2),N,N,N,2)
C      CALL REALTR(A,A(2),N,2)
```

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C     IN THIS CASE, THE COSINE AND SINE COEFFICIENTS ALTERNATE IN A.
C   BY R.C. SINGLETON, STANFORD RESEARCH INSTITUTE, OCT. 1968
C    *** TO CONVERT PROGRAM TO DOUBLE PRECISION, REMOVE C FROM
C           FOLLOWING STATEMENTS
      REAL IM
      DOUBLE PRECISION A,B,AA,BB,AB,BA,BI,AR,SD,CD,SN,CN,FN,PI
      DOUBLE PRECISION ZERO,ONE,TWO,HALF
      DIMENSION A(1),B(1)
      SIN(AA)=DSIN(AA)
      FLOAT(I)=DFLOAT(I)
      INC=IABS(ISN)
      NK=N*INC+2
      NH=NK/2
      SD=3.14159265358979323846264338327950288/FLOAT(2*N)
      CD=2.0*SIN(SD)**2
      SD=SIN(SD+SD)
      SN=0.0
      IF(ISN.LT.0)GO TO 30
      CN=1.0
      A(NK-1)=A(1)
      B(NK-1)=B(1)
   10 DO 20 J=1,NH,INC
      K=NK-J
      AA=A(J)+A(K)
      AB=A(J)-A(K)
      BA=B(J)+B(K)
      BB=B(J)-B(K)
      RE=CN*BA+SN*AB
      IM=SN*BA-CN*AB
      B(K)=IM-BB
      B(J)=IM+BB
      A(K)=AA-RE
      A(J)=AA+RE
      AA=CN-(CD*CN+SD*SN)
      SN=(SD*CN-CD*SN)+SN
C  THE FOLLOWING THREE STATEMENTS COMPENSATE FOR TRUNCATION
C  ERROR.  IF ROUNDED ARITHMETIC IS USED, SUBSTITUTE
C  20 CN=AA
      CN=0.5/(AA**2+SN**2)+0.5
      SN=CN*SN
   20 CN=CN*AA
      RETURN
   30 CN=-1.0
      SD=-SD
      GO TO 10
      END
      SUBROUTINE FASTFT(N,H,ISN)
C        COMPUTES FAST FOURIER TRANSFORM OF 2**N POINTS
C        N = NUMBER OF POINTS
C        H = COMPLEX ARRAY OF DATA TO BE TRANSFORMED
C        ISN = 1 FOR DIRECT TRANSFORM, 0 FOR INVERSE TRANSFORM
      DIMENSION M(20)
      COMPLEX H(N),WK,A,B
      VA=6.2831853070/FLOAT(N)
      IF(ISN.GT.0)VA=-VA
      LOG=1
      K=N
    1 K=K/2
      M(LOG)=K
      IF(K.EQ.1)GO TO 2
```

```
      LOG=LOG+1
      GO TO 1
    2 K=0
      DO 5 L=1,LOG
      NB=2**(L-1)
      LB=N/NB
      LBH=LB/2
      K=0
      DO 5 IB=1,NB
      V=VA*FLOAT(K)
      WK=CMPLX(COS(V),SIN(V))
      IS=LB*(IB-1)
      DO 3 I=1,LBH
      J=IS+I
      JH=J+LBH
      A=H(J)
      B=H(JH)*WK
      H(JH)=A-B
    3 H(J)=A+B
      DO 4 I=2,LOG
      IF(K.LT.M(I))GO TO 5
    4 K=K-M(I)
    5 K=K+M(I)
      K=0
      DO 8 J=1,N
      IF(K.LT.J)GO TO 6
      A=H(J)
      H(J)=H(K+1)
      H(K+1)=A
    6 DO 7 I=1,LOG
      IF(K.LT.M(I))GO TO 8
    7 K=K-M(I)
    8 K=K+M(I)
      IF(ISN.GT.0)RETURN
      A=CMPLX(1./FLOAT(N),0.)
      DO 9 I=1,N
    9 H(I)=H(I)*A
      RETURN
      END
      SUBROUTINE OUTLIE(RESID,K,L,LOOP,IRS,IWS)
C
C SUBROUTINE TO COMPUTE STATISTICS ON B-SPLINE AND/OR FOURIER TREND FIT
C RESIDUAL VECTOR, WHERE K IS THE VECTOR LENGTH. THEN FLAG POINTS WHOSE
C TREND RESIDUALS LIE OUTSIDE A SPECIFIED MULTIPLE (SIGMLT) OF THE TREND
C FIT RESIDUAL SIGMA (RSIGMA)
C
      INTEGER H(3)
      DIMENSION NN(3),NT(3),KA(3),ITERMX(3),LGRMAX(3),EPS(3),KO(3)
      DIMENSION EKNOTS(3,500),FREQ(3,500),SIG(3,500)
      REAL*8 RESID(500)
      COMMON /FILTOP/ IMETH,ISPEC,IBTBS,SIGMLT,NFLAGK
      COMMON /SPLINE/ H,NN,NT,KA,ITERMX,LGRMAX,EPS,KO,SIG,EKNOTS,FREQ
C
C CALCULATE TREND RESIDUAL MEAN
C
      RMEAN=0.0
      DO 10 IB=1,K
   10 RMEAN=RMEAN+RESID(IB)
      RMEAN=RMEAN/REAL(K)
C
```

```
C CALCULATE TREND RESIDUAL SIGMA
C
      RSIGMA=0.0
      DO 20 IB=1,K
   20 RSIGMA=RSIGMA+(RESID(IB)-RMEAN)**2
      RSIGMA=SQRT(RSIGMA/REAL(K-1))
C
C CALCULATE THE TOLERANCE LEVEL FOR TREND RESIDUALS AND PRINT HEADING
C
      TOLER=RSIGMA*SIGMLT
      WRITE(6,100) TOLER
  100 FORMAT(//1X,'<RESIDUALS FOUND OUTSIDE SIGMA TOLERANCE LEVEL OF: ',
     *F15.5,' >'//1X,'NUM',6X,'TIME',14X,'RESIDUAL',6X,'FLAG'/)
C
C BEGIN PROCESSING RESIDUALS AND READING DATA QUALITY INFORMATION ON
C SCRATCH INPUT UNIT IRS
C
      ID=0
      KALT=0
      DO 30 IB=1,L
      READ(IRS) TX,TY,TZ,TB,INOTE,DX,DY,DZ,DB,I
C
C IF GEOCENTRIC LATITUDE OF CURRENT POINT LIES OUTSIDE TOLERANCE LEVEL
C (INOTE = 6), THEN DO NOT INVOLVE POINT IN RESIDUAL OUTLIER CHECK
C
      IF(INOTE.EQ.6) GO TO 30
C
C ID IS ELEMENT NUMBER OF CURRENT RESIDUAL TO BE CHECKED
C
      ID=ID+1
C
C IF MAGNITUDE OF TREND RESIDUAL LIES OUTSIDE THE TOLERANCE LEVEL, RESET
C THE DATA QUALITY FLAG INOTE USING THE FOLLOWING CRITERIA:
C
C INOTE = 3 -->  IF POINT IS A B-SPLINE FIT-OUTLIER
C INOTE = 4 -->  IF POINT IS A FOURIER FIT-OUTLIER
C INOTE = 5 -->  IF POINT IS A COMBINATION B-SPLINE/FOURIER FIT-OUTLIER
C
      IF(ABS(RESID(ID)).LE.TOLER) GO TO 30
C
C DATA POINT HAS BEEN FOUND OUTSIDE THE TOLERANCE LEVEL. PRINT THE
C RESIDUAL, ITS SEQUENTIAL OUTLIER NUMBER (KALT), ITS TIME (I), AND
C THE ASSIGNED DATA QUALITY FLAG (INOTE)
C
      KALT=KALT+1
      RTIME=REAL(I)
      IF(NN(LOOP).GT.0) INOTE=3
      IF(NT(LOOP).GT.0) INOTE=4
      IF((NN(LOOP).GT.0).AND.(NT(LOOP).GT.0)) INOTE=5
      WRITE(6,101) KALT,RTIME,RESID(ID),INOTE
  101 FORMAT(1X,I3,2X,F8.3,7X,F15.5,6X,I4)
C
C WRITE DATA QUALITY INFORMATION BACK OUT TO SCRATCH UNIT IWS
C
   30 WRITE(IWS) TX,TY,TZ,TB,INOTE,DX,DY,DZ,DB,I
C
C SWITCH SCRATCH INPUT AND OUTPUT UNITS FOR NEXT DATA MODIFICATION
C
      CALL SWITCH(IWS,IRS)
      RETURN
```

```
      END
      SUBROUTINE DTREND(LOOP,K,L,IRS,IWS,NKNOT)
C
C SUBROUTINE TO DETREND THE OBSERVED GEOCENTRIC MAGNETIC DATA, THAT IS,
C SUBTRACT THE TREND FIT OF THE RESIDUALS (DX,DY,DZ)
C
      INTEGER H(3)
      DIMENSION NN(3),NT(3),KA(3),ITERMX(3),LGRMAX(3),EPS(3),KO(3)
      DIMENSION EKNOTS(3,500),FREQ(3,500),SIG(3,500)
      REAL*8 BSPLX(500),BSPLY(500),V(5,500),COEF(500),D(13000)
      REAL*8 GSIG(5,500),EKN(500),FRQ(500),SIGCOM(500),RESID(500)
      REAL*8 Q(5,500),TS,TF,WTRMS
      COMMON /SPLINE/ H,NN,NT,KA,ITERMX,LGRMAX,EPS,KO,SIG,EKNOTS,FREQ
      COMMON /BSHARE/ TS,TF,EKN,FRQ,BSPLX,BSPLY,SIGCOM,V,COEF,D,WTRMS,
     *                GSIG,RESID
C
C BEGIN MODIFYING OBSERVED MAGNETIC FIELD, WHICH IS READ IN ON SCRATCH
C INPUT UNIT IRS. NUMOUT COUNTS NUMBER OF GEOCENTRIC LATITUDE OUTLIERS
C
      NUMOUT=0
      KB=0
      DO 10 IB=1,L
      READ(IRS) TX,TY,TZ,TB,INOTE,DX,DY,DZ,DB,I
C
C DETERMINE IF POINT NUMBER IB WAS USED IN TREND FITTING
C
      IF(INOTE.EQ.6) GO TO 20
C
C IF POINT NUMBER IB WAS USED IN TREND FITTING, THEN KB RECORDS THE
C POSITION OF ITS COMPUTED TREND VALUE IN ARRAY V
C
      KB=KB+1
      TREND=REAL(V(1,KB))
      GO TO 30
C
C IF POINT NUMBER IB WAS NOT USED IN TREND FITTING, THEN ITS GEOCENTRIC
C LATITUDE LIES OUTSIDE THE TOLERANCE LEVEL (INOTE = 6), SO CALL BSPLYN
C SUBPROGRAM USING INTERPOLATION MODE:
C
C INTERPOLATION ABSCISSA SUPPLIED -->  TIME I
C INTERPOLATION ORDINATE RETURNED -->  Q(1,1)
C
C PRINT TREND FIT INTERPOLATION HEADING
C
   20 NUMOUT=NUMOUT+1
      IF(NUMOUT.EQ.1) WRITE(6,100)
  100 FORMAT(//1X,'<GEOCENTRIC LATITUDE OUTLIER INTERPOLATION INFORMATIO
     *N>'//1X,'NUM',6X,'TIME',7X,'COMPONENT VALUE'/)
      XINTRP=DBLE(I)
      CALL BSPLYN(TS,TF,NN(LOOP),NKNOT,NT(LOOP),0,0,0,1,0,2,1,40,
     *KA(LOOP),ITERMX(LOOP),LGRMAX(LOOP),EPS(LOOP),K,KO(LOOP),EKN,FRQ,
     *BSPLX,BSPLY,SIGCOM,Q,COEF,D,WTRMS,GSIG,RESID,XINTRP)
      TREND=REAL(Q(1,1))
C
C PRINT TREND FIT INTERPOLATION ABSCISSA, ORDINATE, AND OUTLIER NUMBER
C
      WRITE(6,101) NUMOUT,XINTRP,TREND
  101 FORMAT(1X,I3,2X,F8.3,2X,F20.10)
C
C DETREND ONE COMPONENT OF THE OBSERVED AND RESIDUAL MAGNETIC FIELD
```

```
C DEPENDING UPON THE VALUE OF LOOP
C
   30 IF(LOOP.EQ.1) TX=TX-TREND
      IF(LOOP.EQ.1) DX=DX-TREND
      IF(LOOP.EQ.2) TY=TY-TREND
      IF(LOOP.EQ.2) DY=DY-TREND
      IF(LOOP.EQ.3) TZ=TZ-TREND
      IF(LOOP.EQ.3) DZ=DZ-TREND
C
C IF ALL 3 VECTOR COMPONENTS HAVE BEEN DETRENDED, THEN CALCULATE
C DETRENDED SCALAR VALUES
C
      IF(LOOP.EQ.3) TB=SQRT(TX*TX+TY*TY+TZ*TZ)
      IF(LOOP.EQ.3) DB=SQRT(DX*DX+DY*DY+DZ*DZ)
C
C WRITE MODIFIED MAGNETIC FIELD BACK OUT TO SCRATCH UNIT IWS
C
   10 WRITE(IWS) TX,TY,TZ,TB,INOTE,DX,DY,DZ,DB,I
C
C SWITCH SCRATCH INPUT AND OUTPUT UNITS FOR NEXT DATA MODIFICATION
C
      CALL SWITCH(IWS,IRS)
      RETURN
      END
      SUBROUTINE MODIFY(I,J,L,IRS,IWS)
C
C SUBROUTINE TO WRITE MODIFIED DATA SET TO UNIT IOW WHICH HAS BEEN
C OUTPUT BY THE FILTER FOR THIS TIME INTERVAL OF INTEREST
C
      DIMENSION ICLASS(2,8)
      COMMON /MDFILE/ IOR,IOW,IOF,IOD,IOB,IOF1ST,IOD1ST,IOW1ST,IOWIOF
C
C INITIALIZE ARRAY ICLASS FOR CLASSIFICATION COUNTS IN THIS INTERVAL
C
      DO 1 INTROW=1,2
      DO 1 INTCOL=1,8
    1 ICLASS(INTROW,INTCOL)=0
C
C BEGIN FILTER OUTPUT PROCEDURES FOR THIS INTERVAL, REWIND UNIT IOW
C
      REWIND IOW
C
C SETUP FOR DATA QUALITY CLASSIFICATION COUNTER ICLASS:
C
C ICLASS(1,II) -->  STATUS ON TOTAL DATA SET EXISTING ON UNIT IOW
C ICLASS(2,II) -->  STATUS ON FILTERED OUTPUT DATA SET FOR THIS INTERVAL
C
C COUNTER DEFINITIONS:
C
C NRIOW COUNTS TOTAL RECORDS EXISTING ON UNIT IOW
C
      NRIOW=0
C
C CHECK IF CURRENTLY GENERATED FILTER OUTPUT WILL BE FIRST DATA
C (IOW1ST = 1) OR APPENDED DATA (IOW1ST = 0) ON UNIT IOW.
C IF APPENDED, THEN POSITION FILE MARKER AFTER LAST EXISTING RECORD
C
      IF(IOW1ST.EQ.1) GO TO 15
    5 READ(IOW,200,END=10) IYR,IDAY,IETIME,GLAT,GCLAT,GLON,GMLAT,GMLON,
     *ALT,CALT,BX,BY,BZ,BB,HX,HY,HZ,HB,TX,TY,TZ,TB,DX,DY,DZ,DB,CX,CY,CZ,
```

```
     *CB,IDIR,INOTE
  200 FORMAT(I2,I4,I6,7F7.2,20F8.1,2I5)
      NRIOW=NRIOW+1
C
C UPDATE QUALITY CLASSIFICATION COUNTS OF DATA SET CURRENTLY ON UNIT IOW
C
      ICLASS(1,INOTE+1)=ICLASS(1,INOTE+1)+1
      GO TO 5
   10 BACKSPACE IOW
C
C COUNTER DEFINITIONS:
C
C II IS CURRENT NUMBER OF POINTS READ ON UNIT IOR
C JJ IS CURRENT NUMBER OF POINTS FOUND IN TIME INTERVAL OF INTEREST
C LL IS CURRENT NUMBER OF MODIFIED POINTS
C
   15 II=0
      JJ=0
      LL=0
C
C BEGIN READING INPUT DATA SET ON UNIT IOR
C
   20 READ(IOR,200,END=35) IYR,IDAY,IETIME,GLAT,GCLAT,GLON,GMLAT,GMLON,
     *ALT,CALT,BX,BY,BZ,BB,HX,HY,HZ,HB,TX,TY,TZ,TB,DX,DY,DZ,DB,CX,CY,CZ,
     *CB,IDIR,INOTE
      II=II+1
C
C CHECK IF CURRENT POINT IS WITHIN TIME INTERVAL OF INTEREST:
C
C INTERVAL RANGES FROM RECORD NUMBER (J-I) TO (J-1) ON UNIT IOR
C
      IF(II.LT.J-I) GO TO 20
      IF(II.GT.J-1) GO TO 35
C
C CURRENT POINT LIES WITHIN THE TIME INTERVAL OF INTEREST. CHECK IF ALL
C MODIFIED DATA POINTS (L) HAVE BEEN WRITTEN OUT, IF SO, THEN WRITE OUT
C DUPLICATE RECORD
C
      IF(LL.GE.L) GO TO 30
      JJ=JJ+1
C
C IF ALL MODIFIED POINTS HAVE NOT BEEN WRITTEN OUT, THEN READ NEXT SET
C OF MODIFICATION INFORMATION ON SCRATCH UNIT IRS
C
      READ(IRS) PX,PY,PZ,PB,MNOTE,QX,QY,QZ,QB,III
      IF(JJ.LT.III) GO TO 25
C
C IF CURRENT POINT IN INTERVAL (JJ) MATCHES CURRENT POINT TO BE MODIFIED
C (III), THEN WRITE OUT THE MODIFIED POINT AND RECORD MODIFICATION TOTAL
C
      LL=LL+1
      WRITE(IOW,200) IYR,IDAY,IETIME,GLAT,GCLAT,GLON,GMLAT,GMLON,ALT,
     *CALT,BX,BY,BZ,BB,HX,HY,HZ,HB,PX,PY,PZ,PB,QX,QY,QZ,QB,CX,CY,CZ,CB,
     *IDIR,MNOTE
C
C UPDATE QUALITY CLASSIFICATION COUNTS OF DATA SET FOR FILTER OUTPUT
C
      ICLASS(2,MNOTE+1)=ICLASS(2,MNOTE+1)+1
      GO TO 20
C
```

```
C IF CURRENT POINT IN INTERVAL DOES NOT MATCH CURRENT POINT TO BE
C MODIFIED, THEN WRITE OUT DUPLICATE RECORD AND BACKSPACE UNIT IRS TO
C RETAIN CURRENT MODIFICATION INFORMATION
C
   25 BACKSPACE IRS
C
C UPDATE QUALITY CLASSIFICATION COUNTS OF DATA SET FOR FILTER OUTPUT
C
   30 ICLASS(2,INOTE+1)=ICLASS(2,INOTE+1)+1
C
C WRITE OUT DUPLICATE DATA RECORDS TO UNIT IOW
C
      WRITE(IOW,200) IYR,IDAY,IETIME,GLAT,GCLAT,GLON,GMLAT,GMLON,ALT,
     *CALT,BX,BY,BZ,BB,HX,HY,HZ,HB,TX,TY,TZ,TB,DX,DY,DZ,DB,CX,CY,CZ,CB,
     *IDIR,INOTE
      GO TO 20
C
C ADJUST CLASSIFICATION COUNTS FOR TOTAL UNIT IOW DATA SET DUE TO NEWLY
C APPENDED FILTER DATA
C
   35 NRIOW=NRIOW+I
      DO 40 IADD=1,8
   40 ICLASS(1,IADD)=ICLASS(1,IADD)+ICLASS(2,IADD)
C
C PRINT QUALITY CLASSIFICATION STATUS OF DATA SET OUTPUT FROM THE FILTER
C
      WRITE(6,201)
  201 FORMAT(//1X,'<FILTER OUTPUT DATA CLASSIFICATION>')
      WRITE(6,202) (ICLASS(2,ICL),ICL=1,8),I
  202 FORMAT(/6X,'FLAG',4X,'COUNT',27X,'DESCRIPTION'//1X,'INOTE = 0',4X,
     *I5,' -->  NO LIMITATIONS OR CONSTRAINTS'/1X,'INOTE = 1',4X,I5,' --
     *>  GROSS-OUTLIER WITH RESPECT TO OBSERVED - COMPUTED FIELD'/1X,'IN
     *OTE = 2',4X,I5,' -->  PADDED TIME-GAP VALUE'/1X,'INOTE = 3',4X,I5,
     *' -->  B-SPLINE FIT-OUTLIER'/1X,'INOTE = 4',4X,I5,' -->  FOURIER F
     *IT-OUTLIER'/1X,'INOTE = 5',4X,I5,' -->  COMBINATION B-SPLINE/FOURI
     *ER FIT-OUTLIER'/1X,'INOTE = 6',4X,I5,' -->  GEOCENTRIC LATITUDE LI
     *ES OUTSIDE TOLERANCE LEVEL'/1X,'INOTE = 7',4X,I5,' -->  SATELLITE
     *VELOCITY VECTOR DIRECTION IS INDETERMINABLE'//1X,'TOTAL ====>  ',I
     *5,' RECORDS   (EACH RECORD HAS 4 COMPONENTS: X, Y, Z, AND B)'//)
C
C PRINT QUALITY CLASSIFICATION STATUS OF TOTAL DATA SET ON UNIT IOW
C
      WRITE(6,203) IOW
  203 FORMAT(//1X,'<TOTAL FILTERED OUTPUT DATA CLASSIFICATION EXISTING O
     *N UNIT ',I2,'>')
      WRITE(6,202) (ICLASS(1,ICL),ICL=1,8),NRIOW
      RETURN
      END
      SUBROUTINE DPINFO(IWP,NTOTL)
C
C SUBROUTINE TO PLOT VARIOUS DATA PARAMETERS: TIME/LATITUDE POSITION,
C VELOCITY VECTOR DIRECTION, AND TIME-GAP/OUTLIER INFORMATION
C
      CHARACTER*1 SYMBOL(8)
      LOGICAL*1 INUM
      DIMENSION X(500),Y(500)
      COMMON /EPHEMS/ ORBINC,ERAD,IEPDAY,INCREM,INTRVL
      COMMON /LIMITS/ DXOL,DYOL,DZOL,DBOL,XWINDO,YWINDO,ZWINDO,BWINDO,
     *                ABVLAT,TRNLAT,ITMGAP
C
```

```
C DEFINE SYMBOLS USED IN PLOTTING
C
      DATA SYMBOL /'+','-','*','O','G','B','F','C'/
C
C INITIALIZE PRINTER PLOTTING, DEFINE CARTESIAN OBJECT SPACE, AND
C OVERLAY CARTESIAN LINEAR GRID WITH TICK MARKS
C
      XMAX=REAL(NTOTL)
      CALL PLOTST(00001,1)
      CALL SETGRD(11.0,12.0,123.0,62.0,1)
      CALL OGRID(1.0,XMAX,8,'I3)',1,-90.0,90.0,18,'I3)',2,0)
C
C PLOT THE LATITUDE TOLERANCE WINDOW DEFINED BY +ABVLAT AND -ABVLAT
C USING THE SYMBOL --> =
C
      DO 10 L=1,2
      DO 20 K=1,NTOTL
      IF(L.EQ.1) X(K)=REAL(K)
      IF(L.EQ.1) Y(K)=ABVLAT
   20 IF(L.EQ.2) Y(K)=-Y(K)
   10 CALL PLOT(X,Y,NTOTL,'=')
C
C PLOT 8 DATA POINT PARAMETERS, ONE AT A TIME
C
      DO 30 IDQUAL=1,8
C
C REWIND SCRATCH UNIT IWP, WHICH CONTAINS PARAMETER INFORMATION
C
      REWIND IWP
      IK=0
C
C BEGIN READING PARAMETER INFORMATION FOR ALL NTOTL POINTS ON UNIT IWP
C
      DO 40 K=1,NTOTL
      READ(IWP) GCLAT,IDIR,INOTE,I
C
C                CHECKING SEQUENCE                              FLAGS
C
C IF IDQUAL = 1, CHECK FOR ASCENDING POINTS                   IDIR  =  1
C IF IDQUAL = 2, CHECK FOR DESCENDING POINTS                  IDIR  = -1
C IF IDQUAL = 3, CHECK FOR TURN-AROUND POINTS                 IDIR  =  0
C IF IDQUAL = 4, CHECK FOR GROSS-OUTLIERS                     INOTE =  1
C IF IDQUAL = 5, CHECK FOR PADDED TIME-GAP POINTS             INOTE =  2
C IF IDQUAL = 6, CHECK FOR B-SPLINE FIT-OUTLIERS              INOTE =  3
C IF IDQUAL = 7, CHECK FOR FOURIER FIT-OUTLIERS               INOTE =  4
C IF IDQUAL = 8, CHECK FOR B-SPLINE/FOURIER FIT-OUTLIERS      INOTE =  5
C
      IF((IDQUAL.EQ.1).AND.(IDIR.GT.0)) GO TO 50
      IF((IDQUAL.EQ.2).AND.(IDIR.LT.0)) GO TO 50
      IF((IDQUAL.EQ.3).AND.(IDIR.EQ.0)) GO TO 50
      IF((IDQUAL.EQ.4).AND.(INOTE.EQ.1)) GO TO 50
      IF((IDQUAL.EQ.5).AND.(INOTE.EQ.2)) GO TO 50
      IF((IDQUAL.EQ.6).AND.(INOTE.EQ.3)) GO TO 50
      IF((IDQUAL.EQ.7).AND.(INOTE.EQ.4)) GO TO 50
      IF((IDQUAL.EQ.8).AND.(INOTE.EQ.5)) GO TO 50
      GO TO 40
C
C IF PARTICULAR DATA QUALITY IS CURRENTLY FOUND, THEN STORE POINT TIME
C IN ARRAY X, POINT LATITUDE IN ARRAY Y, AND RECORD TOTAL POINTS HAVING
C THIS QUALITY
```

```
C
   50 IK=IK+1
      X(IK)=REAL(I)
      Y(IK)=GCLAT
   40 CONTINUE
C
C PLOT POINTS HAVING CURRENT DATA QUALITY WITH FOLLOWING SYMBOLS:
C ASCENDING --> +, DESCENDING --> -, TURNING --> *, GROSS OUTLIER --> 0,
C TIME-GAP --> G, B-SPLINE FIT OUTLIER --> B, FOURIER FIT OUTLIER --> F,
C COMBINATION B-SPLINE/FOURIER FIT OUTLIER --> C
C
   30 IF(IK.NE.0) CALL PLOT(X,Y,IK,SYMBOL(IDQUAL))
C
C PRINT HEADING AND LEGEND
C
      CALL HORLIN('DATA QUALITY INFORMATION FOR INTERVAL: ',39,66.0,
     *67.0,0,0)
      CALL EDIT(INTRVL,'I2)',INUM,NNUM,IBL)
      CALL HORLIN(INUM,2,66.0,67.0,40,0)
      CALL HORLIN('ASCENDING --> +  DESCENDING --> -  TURNING --> *  GRO
     *SS OUTLIER --> 0  TIME-GAP --> G  B-SPLINE FIT OUTLIER --> B',113,
     *66.0,65.0,0,0)
      CALL HORLIN('FOURIER FIT OUTLIER --> F  COMBINATION B-SPLINE/FOURI
     *ER FIT OUTLIER --> C  LATITUDE TOLERANCE RANGE --> =        ',113,
     *66.0,64.0,0,0)
C
C LABEL PLOT AXES
C
      CALL HORLIN('TIME',4,66.0,8.0,0,0)
      CALL VERLIN('LATITUDE',8,5.0,37.0,0,0)
C
C TERMINATE PLOTTING SEQUENCE
C
      CALL ENDPLT
      RETURN
      END
      SUBROUTINE SWITCH(IWS,IRS)
C
C SWITCH SCRATCH INPUT AND OUTPUT UNITS BETWEEN UNITS ISC1 AND ISC2. IWS
C AND IRS ARE CURRENT OUTPUT AND INPUT UNITS, RESPECTIVELY
C
      AUX=IWS
      IWS=IRS
      IRS=AUX
C
C REWIND THE NEW IRS UNIT FOR NEXT READING AND THE NEW IWS UNIT FOR NEXT
C WRITING
C
      REWIND IRS
      REWIND IWS
      RETURN
      END
      SUBROUTINE STEP5
C
C SUBROUTINE TO WRITE OUT FINAL MODIFIED SATELLITE MAGNETIC FIELD DATA
C
C THREE VERSIONS OF FINAL DATA TAPES ARE AVAILABLE INDICATED BY IBTBS:
C
C     (1) IF IBTBS = 0: WRITE OUT TO UNIT IOF:
C                          A) EPHEMERIS INFORMATION
```

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C                       B) TOPOCENTRIC OBSERVED FIELD
C                       C) TOPOCENTRIC RESIDUAL FIELD
C                       D) TOPOCENTRIC COMPUTED FIELD
C                       E) DATA QUALITY INFORMATION
C
C     (2) IF IBTBS = 1: WRITE OUT TO UNIT IOF:
C                       A) EPHEMERIS INFORMATION                <---
C                       B) FIT/MAGSAT OBSERVED FIELD            SAME
C                       C) FIT/MAGSAT RESIDUAL FIELD            AS
C                       D) TOPOCENTRIC OBSERVED FIELD           UNIT
C                       E) TOPOCENTRIC RESIDUAL FIELD           IOW
C                       F) TOPOCENTRIC COMPUTED FIELD
C                       G) DATA QUALITY INFORMATION             <---
C                       H) GEOMAGNETIC LATITUDE OUTLIER INFORMATION
C
C                       WRITE OUT TO BINARY UNIT IOB IN FIT FORMAT:
C                       A) EPHEMERIS INFORMATION
C                       B) DATA QUALITY INFORMATION
C                       C) FIT/MAGSAT OBSERVED FIELD
C                       D) GEOMAGNETIC LATITUDE OUTLIER INFORMATION
C
C     (3) IF IBTBS = 2: SAME AS OPTION (2), BUT AN ADDITIONAL DATA TAPE,
C                       ANALOGOUS TO TAPE WRITTEN TO UNIT IOF, WILL BE
C                       WRITTEN OUT TO UNIT IOD IN A DESIRED SPACECRAFT
C                       COORDINATE SYSTEM
C
      DIMENSION EU(3),CA(3,3),QI(3),QF(3),CF(3),RF(3,3),RC(3,3)
      DIMENSION A(28,100),IA(28,100),KCLASS(4,8),IFS(4)
      DIMENSION NOUTX(8),NOUTY(8),NOUTZ(8),NOUTB(8),NRCOUT(8)
      DIMENSION NOLDX(8),NOLDY(8),NOLDZ(8),NOLDB(8),NRCOLD(8)
      EQUIVALENCE (A(1,1),IA(1,1))
      COMMON /MDFILE/ IOR,IOW,IOF,IOD,IOB,IOF1ST,IOD1ST,IOW1ST,IOWIOF
      COMMON /COTRAN/ EU,CA,QI,QF,CF,RF,RC
      COMMON /EPHEMS/ ORBINC,ERAD,IEPDAY,INCREM,INTRVL
      COMMON /FILTOP/ IMETH,ISPEC,IBTBS,SIGMLT,NFLAGK
      COMMON /LIMITS/ DXOL,DYOL,DZOL,DBOL,XWINDO,YWINDO,ZWINDO,BWINDO,
     *                ABVLAT,TRNLAT,ITMGAP
      DATA IFS /22,23,24,25/
C
C INITIALIZE MAGNETIC LATITUDE OUTLIER COUNTER ARRAYS IN THIS INTERVAL
C
      DO 1 INTCOL=1,8
      NOUTX(INTCOL)=0
      NOUTY(INTCOL)=0
      NOUTZ(INTCOL)=0
      NOUTB(INTCOL)=0
      NRCOUT(INTCOL)=0
      NOLDX(INTCOL)=0
      NOLDY(INTCOL)=0
      NOLDZ(INTCOL)=0
      NOLDB(INTCOL)=0
      NRCOLD(INTCOL)=0
C
C INITIALIZE ARRAY KCLASS FOR CLASSIFICATION COUNTS IN THIS INTERVAL
C
      DO 1 INTROW=1,4
    1 KCLASS(INTROW,INTCOL)=0
C
C GENERATE VECTOR (IFS) WHICH PERMUTES MAGNETIC LATITUDE TOLERANCE FLAGS
C FROM FIT/MAGSAT TO DESIRED SPACECRAFT COORDINATES FOR OUTPUT TAPE
```

```
C
      IFS(1)=NINT(RC(1,1))*22+NINT(RC(1,2))*23+NINT(RC(1,3))*24
      IFS(2)=NINT(RC(2,1))*22+NINT(RC(2,2))*23+NINT(RC(2,3))*24
      IFS(3)=NINT(RC(3,1))*22+NINT(RC(3,2))*23+NINT(RC(3,3))*24
C
C PRINT HEADING FOR STEP5 POST-FILTER PROCESSING
C
      WRITE(6,200)
  200 FORMAT('1','**************************************************'
     */1X,'**** P O S T - F I L T E R   P R O C E S S I N G ****'/1X,'**
     ************************************************')
C
C BEGIN FINAL DATA MODIFICATION AND OUPUT:
C
C REWIND INPUT UNITS -->  IOW     REWIND OUTPUT UNITS -->  IOF
C                                                          IOD
C                                                          IOB
C
      REWIND IOW
      REWIND IOF
      REWIND IOD
      REWIND IOB
C
C SETUP FOR DATA QUALITY CLASSIFICATION COUNTER KCLASS:
C
C KCLASS(1,II) -->  STATUS ON UNIT IOF FILTER OUTPUT FOR THIS INTERVAL
C KCLASS(2,II) -->  STATUS ON UNIT IOB FILTER OUTPUT FOR THIS INTERVAL
C KCLASS(3,II) -->  STATUS OF ENTIRE DATA SETS ON UNITS IOF AND IOB
C KCLASS(4,II) -->  STATUS OF ENTIRE DATA SET ON UNIT IOD
C
C COUNTER DEFINITIONS:
C
C NTOPO  COUNTS TOTAL RECORDS READ FROM UNIT IOW AND WRITTEN TO UNIT IOF
C        IN TOPOCENTRIC COORDINATES FOR THIS INTERVAL
C NTOTR  COUNTS TOTAL RECORDS READ FROM UNIT IOW AND WRITTEN TO UNIT IOF
C        IN FIT/MAGSAT COORDINATES FOR THIS INTERVAL
C NSAT   COUNTS TOTAL RECORDS WRITTEN TO UNIT IOD IN DESIRED SPACECRAFT
C        COORDINATES FOR THIS INTERVAL
C NFIT   COUNTS TOTAL NON-ZERO PADDED RECORDS WRITTEN TO UNIT IOB FOR
C        THIS INTERVAL
C NBLK   COUNTS TOTAL 100-RECORD BLOCKS WRITTEN IN BINARY FOR FIT INPUT
C        ON UNIT IOB
C NRIOF  COUNTS TOTAL RECORDS EXISTING ON UNIT IOF
C NRIOD  COUNTS TOTAL RECORDS EXISTING ON UNIT IOD
C NBIOB  COUNTS TOTAL NON-ZERO PADDED RECORDS EXISTING ON UNIT IOB
C
      NTOPO=0
      NTOTR=0
      NSAT=0
      NFIT=0
      NBLK=0
      NRIOF=0
      NRIOD=0
      NBIOB=0
C
C NSTART STORES POSITION OF FIRST ZERO-PADDED RECORD OF LAST 100-RECORD
C BINARY BLOCK EXISTING ON UNIT IOB PRIOR TO THIS RUN. THIS INFORMATION
C IS USED WHEN APPENDING DATA (SEE BELOW)
C
      NSTART=1
```

```
C
C FINAL DATA OUTPUT VERSION OPTION DEPENDING ON IBTBS
C
      IF(IBTBS.NE.0) GO TO 30
C
C IF IBTBS = 0, CHECK IF CURRENTLY GENERATED OUTPUT DATA WILL BE FIRST
C DATA (IOF1ST = 1) OR APPENDED DATA (IOF1ST = 0) ON UNIT IOF.
C IF APPENDED, THEN POSITION FILE MARKER AFTER LAST EXISTING RECORD
C
      IF(IOF1ST.EQ.1) GO TO 15
    5 READ(IOF,201,END=10) IYR,IDAY,IETIME,GLAT,GCLAT,GLON,GMLAT,GMLON,
     *ALT,CALT,TX,TY,TZ,TB,DX,DY,DZ,DB,CX,CY,CZ,CB,IDIR,INOTE
  201 FORMAT(I2,I4,I6,7F7.2,64X,12F8.1,2I5)
      NRIOF=NRIOF+1
C
C UPDATE QUALITY CLASSIFICATION COUNTS OF TOTAL TOPOCENTRIC OUTPUT DATA
C SET PRESENTLY RESIDING ON UNIT IOF
C
      KCLASS(3,INOTE+1)=KCLASS(3,INOTE+1)+1
      GO TO 5
   10 BACKSPACE IOF
C
C IF IBTBS = 0, WRITE OUT TOPOCENTRIC FORMAT TAPE. NEW UNIT IOF TAPE
C HAS IDENTICAL INFORMATION AS INPUT UNIT IOW TAPE, EXCEPT UNMODIFIED
C FIT/MAGSAT MAGNETIC FIELD COMPONENTS ARE OMITTED
C
   15 READ(IOW,202,END=20) IYR,IDAY,IETIME,GLAT,GCLAT,GLON,GMLAT,GMLON,
     *ALT,CALT,BX,BY,BZ,BB,HX,HY,HZ,HB,TX,TY,TZ,TB,DX,DY,DZ,DB,CX,CY,CZ,
     *CB,IDIR,INOTE
  202 FORMAT(I2,I4,I6,7F7.2,20F8.1,2I5)
C
C DETERMINE UNIT IOW TIME INTERVALS TO BE PROCESSED DURING THIS STEP:
C
C IF IOWIOF = 0 -->  PROCESS INTRVL ONLY
C IF IOWIOF = 1 -->  PROCESS INTRVL AND PRECEEDING INTERVALS
C IF IOWIOF = 2 -->  PROCESS ALL INTERVALS
C
C IF IOWIOF = 0 -->  IF CURRENT DAY (IDAY) IS EARLIER THAN EPOCH DAY
C                    (IEPDAY), THEN REJECT POINT
C
      IF((IOWIOF.EQ.0).AND.(IDAY.LT.IEPDAY)) GO TO 15
C
C DETERMINE RELATIVE TIME OF DATA POINT (ICTIME) WITH RESPECT TO
C BEGINNING OF EPOCH DAY (IEPDAY), THEN DETERMINE ITS TIME INTERVAL (NI)
C WITH RESPECT TO INTERVAL WIDTH (INCREM).
C
      ICTIME=(IDAY-IEPDAY)*86400+IETIME
      NI=INT(ICTIME/INCREM)+1
C
C IF IOWIOF = 0 -->  IF CURRENT TIME INTERVAL IS LESS THAN INTERVAL OF
C                    INTEREST, THEN REJECT POINT
C
      IF((IOWIOF.EQ.0).AND.(NI.LT.INTRVL)) GO TO 15
C
C IF IOWIOF = 0 OR 1 -->  IF CURRENT TIME INTERVAL IS GREATER THAN
C                         INTERVAL OF INTEREST, THEN REJECT POINT
C
      IF((IOWIOF.LE.1).AND.(NI.GT.INTRVL)) GO TO 20
C
C BEGIN COUNT OF DATA ACCEPTED FROM UNIT IOW
```

```
C
      NTOPO=NTOPO+1
C
C UPDATE QUALITY CLASSIFICATION COUNTS OF TOPOCENTRIC OUTPUT DATA SET
C
      KCLASS(1,INOTE+1)=KCLASS(1,INOTE+1)+1
C
C WRITE TOPOCENTRIC DATA SET OUT TO UNIT IOF
C
      WRITE(IOF,201) IYR,IDAY,IETIME,GLAT,GCLAT,GLON,GMLAT,GMLON,ALT,
     *CALT,TX,TY,TZ,TB,DX,DY,DZ,DB,CX,CY,CZ,CB,IDIR,INOTE
      GO TO 15
C
C CALCULATE TOTAL NUMBER OF COMPONENTS (NCOMPF) OUTPUT BY THE FILTER
C EXCLUDING PADDED TIME-GAP RECORDS
C
   20 NCOMPF=4*(NTOPO-KCLASS(1,3))
C
C END PROCESSING OF FINAL TOPOCENTRIC FORMAT TAPE. PRINT CLASSIFICATION
C COUNTS FOR THIS TAPE
C
      WRITE(6,203) IOF
  203 FORMAT(//1X,'<STEP5 TOPOCENTRIC FORMATTED OUTPUT DATA CLASSIFICATI
     *ON ON UNIT ',I2,'>')
      WRITE(6,204) (KCLASS(1,KCL),KCL=1,8),NTOPO,NCOMPF
  204 FORMAT(/6X,'FLAG',4X,'COUNT',27X,'DESCRIPTION'//1X,'INOTE = 0',4X,
     *I5,' -->  NO LIMITATIONS OR CONSTRAINTS'/1X,'INOTE = 1',4X,I5,' --
     *>  GROSS-OUTLIER WITH RESPECT TO OBSERVED - COMPUTED FIELD'/1X,'IN
     *OTE = 2',4X,I5,' -->  PADDED TIME-GAP VALUE'/1X,'INOTE = 3',4X,I5,
     *' -->  B-SPLINE FIT-OUTLIER'/1X,'INOTE = 4',4X,I5,' -->  FOURIER F
     *IT-OUTLIER'/1X,'INOTE = 5',4X,I5,' -->  COMBINATION B-SPLINE/FOURI
     *ER FIT-OUTLIER'/1X,'INOTE = 6',4X,I5,' -->  GEOCENTRIC LATITUDE LI
     *ES OUTSIDE TOLERANCE LEVEL'/1X,'INOTE = 7',4X,I5,' -->  SATELLITE
     *VELOCITY VECTOR DIRECTION IS INDETERMINABLE'//1X,'TOTAL ====>  ',I
     *5,' RECORDS'//1X,'TOTAL ====>  ',I5,' COMPONENTS'/)
C
C ADJUST UNIT IOF CLASSIFICATION COUNTS DUE TO NEWLY APPENDED DATA
C
      NRIOF=NRIOF+NTOPO
      DO 25 IADD=1,8
   25 KCLASS(3,IADD)=KCLASS(3,IADD)+KCLASS(1,IADD)
C
C CALCULATE TOTAL NUMBER OF COMPONENTS (NCOMPT) EXISTING ON UNIT IOF
C EXCLUDING PADDED TIME-GAP RECORDS
C
      NCOMPT=4*(NTOPO-KCLASS(3,3))
C
C PRINT STATUS OF ENTIRE OUTPUT DATA SET EXISTING ON UNIT IOF
C
      WRITE(6,205) IOF
  205 FORMAT(//1X,'<TOTAL TOPOCENTRIC FORMATTED OUTPUT DATA CLASSIFICATI
     *ON EXISTING ON UNIT ',I2,'>')
      WRITE(6,204) (KCLASS(3,KCL),KCL=1,8),NRIOF,NCOMPT
      RETURN
C
C IF IBTBS = 1 OR 2, CHECK IF CURRENTLY GENERATED OUTPUT DATA WILL BE
C FIRST DATA (IOF1ST = 1) OR APPENDED DATA (IOF1ST = 0) ON UNITS IOF AND
C IOB, AND FIRST DATA (IOD1ST = 1) OR APPENDED DATA (IOD1ST = 0) ON UNIT
C IOD. IF APPENDED, THEN POSITION FILE MARKER AFTER LAST EXISTING RECORD
C
```

```
   30 IF(IOFIST.EQ.1) GO TO 70
C
C POSITION FILE MARKER FOR APPENDING DATA ON UNIT IOF
C
   40 READ(IOF,206,END=45) IYR,IDAY,IETIME,GLAT,GCLAT,GLON,GMLAT,GMLON,
     *ALT,CALT,PX,PY,PZ,PB,HX,HY,HZ,HB,TX,TY,TZ,TB,DX,DY,DZ,DB,CX,CY,CZ,
     *CB,IDIR,INOTE,IAX,IAY,IAZ,IAB
  206 FORMAT(I2,I4,I6,7F7.2,20F8.1,2I5,4I2)
      NRIOF=NRIOF+1
C
C UPDATE QUALITY CLASSIFICATION COUNTS OF TOTAL FIT/MAGSAT OUTPUT DATA
C SET PRESENTLY RESIDING ON UNIT IOF
C
      KCLASS(3,INOTE+1)=KCLASS(3,INOTE+1)+1
C
C IF CURRENT POINT IS A PADDED TIME-GAP VALUE (INOTE = 2), THEN DO NOT
C UPDATE MAGNETIC LATITUDE OUTLIER COUNTS
C
      IF(INOTE.EQ.2) GO TO 40
C
C UPDATE MAGNETIC LATITUDE OUTLIER RECORD COUNTS
C
      IF((IAX.EQ.0).OR.(IAY.EQ.0).OR.(IAZ.EQ.0).OR.(IAB.EQ.0))
     *NRCOLD(INOTE+1)=NRCOLD(INOTE+1)+1
C
C OUTLIER COUNTER DEFINITIONS FOR INDIVIDUAL DATA QUALITY FLAGS:
C
C NOLDX-B FOR ENTIRE UNIT IOF DATA SET IS ANALOGOUS TO NOUTX-B FOR
C CURRENT FILTER OUTPUT DATA SET (SEE DESCRIPTION BELOW)
C
C TALLY MAGNETIC LATITUDE OUTLIER COMPONENTS EXISTING ON UNIT IOF
C
      IF(IAX.EQ.0) NOLDX(INOTE+1)=NOLDX(INOTE+1)+1
      IF(IAY.EQ.0) NOLDY(INOTE+1)=NOLDY(INOTE+1)+1
      IF(IAZ.EQ.0) NOLDZ(INOTE+1)=NOLDZ(INOTE+1)+1
      IF(IAB.EQ.0) NOLDB(INOTE+1)=NOLDB(INOTE+1)+1
      GO TO 40
   45 BACKSPACE IOF
C
C POSITION FILE MARKER FOR APPENDING DATA ON UNIT IOB
C
   50 READ(IOB,END=60) A
C
C CHECK THE MODIFIED JULIAN DAY STORED IN FIRST ELEMENT OF EACH RECORD
C OR COLUMN OF THIS 100-RECORD BLOCK (SEE FIT INPUT FORMAT BELOW):
C
C IF MOD JUL DAY IS NOT ZERO -->  DATA EXISTS ON THE RECORD
C IF MOD JUL DAY IS ZERO     -->  NO DATA EXISTS ON THE RECORD (PADDED)
C
C TOTAL NON-PADDED RECORDS:  NBIOB
C CURRENT RECORD CHECKED:    NSTART
C PROCESSING ORDER:          FROM RECORD NUMBER 100 --> 1 SO THAT
C                            FULL-RECORD CHECK TIME IS MINIMIZED
C
      NSTART=101
   55 NSTART=NSTART-1
C
C IF ENTIRE BLOCK IS PADDED (NSTART = 0), THEN SET APPEND POSITION AT
C THE FIRST RECORD, THUS OVERWRITING THE ENTIRE PADDED BLOCK
C
```

```
      IF(NSTART.EQ.0) GO TO 65
C
C IF THE FIRST NSTART RECORDS ARE NOT ZERO, THEN SET APPEND POSITION AT
C NEXT RECORD AFTER THESE, THUS OVERWRITING THE PADDED PORTION
C
      IF(IA(1,NSTART).NE.0) GO TO 65
      GO TO 55
C
C ENTRY POSITION IF END OF FILE MARK IS ENCOUNTERED, TREAT THE SAME AS
C IF ENTIRE PADDED BLOCK HAS BEEN ENCOUNTERED
C
   60 NSTART=0
C
C UPDATE COUNT OF NON-ZERO RECORDS EXISTING ON UNIT IOB
C
   65 NBIOB=NBIOB+NSTART
C
C IF A FULL NON-ZERO 100-RECORD BLOCK WAS ENCOUNTERED, THEN READ AND
C CHECK NEXT BLOCK UNTIL A BLOCK IS FOUND WITH PADDED VALUES OR AN END
C OF FILE MARK IS ENCOUNTERED
C
      IF(NSTART.EQ.100) GO TO 50
C
C ADJUST NSTART FROM LAST NON-ZERO RECORD POSITION TO APPEND POSITION
C
      NSTART=NSTART+1
C
C SET UNIT IOB FILE POSITION MARKER TO REWRITE LAST DATA BLOCK
C
      BACKSPACE IOB
   70 IF((IBTBS.NE.2).OR.(IOD1ST.EQ.1)) GO TO 85
C
C POSITION FILE MARKER FOR APPENDING DATA ON UNIT IOD
C
   75 READ(IOD,206,END=80) IYR,IDAY,IETIME,GLAT,GCLAT,GLON,GMLAT,GMLON,
     *ALT,CALT,UX,UY,UZ,UB,WX,WY,WZ,WB,TX,TY,TZ,TB,DX,DY,DZ,DB,CX,CY,CZ,
     *CB,IDIR,INOTE,IAX,IAY,IAZ,IAB
      NRIOD=NRIOD+1
C
C UPDATE QUALITY CLASSIFICATION COUNTS OF TOTAL DESIRED SPACECRAFT
C OUTPUT DATA SET PRESENTLY RESIDING ON UNIT IOD
C
      KCLASS(4,INOTE+1)=KCLASS(4,INOTE+1)+1
      GO TO 75
   80 BACKSPACE IOD
C
C IF IBTBS = 1 OR 2, WRITE OUT FIT/MAGSAT FORMAT TAPES AND IF IBTBS = 2,
C WRITE OUT DESIRED SPACECRAFT FORMAT TAPE. BINARY OUTPUT IS WRITTEN TO
C UNIT IOB IN BLOCKS OF 100 RECORDS.
C
C INITIALIZE COLUMN NUMBER NSTART THROUGH NUMBER 100 OF BLOCK STORAGE
C ARRAYS A AND IA FOR GENERATION OF NEXT DATA BLOCK
C
   85 DO 90 II=NSTART,100
      DO 90 JJ=1,28
      IA(JJ,II)=0
   90 A(JJ,II)=0.0
C
C PROCESSING FOR 100-RECORD DATA BLOCKS IN THIS RUN:
C
```

```
C FIRST BLOCK       -->  FIRST 101 - NSTART RECORDS FROM INPUT UNIT IOW
C                        NSTART - 1 RECORDS ALREADY EXIST FROM UNIT IOB
C SUBSEQUENT BLOCKS -->  NEXT 100 RECORDS FROM INPUT UNIT IOW
C
      DO 95 II=NSTART,100
  100 READ(IOW,202,END=115) IYR,IDAY,IETIME,GLAT,GCLAT,GLON,GMLAT,GMLON,
     *ALT,CALT,BX,BY,BZ,BB,OX,OY,OZ,OB,TX,TY,TZ,TB,DX,DY,DZ,DB,CX,CY,CZ,
     *CB,IDIR,INOTE
C
C DETERMINE UNIT IOW TIME INTERVALS TO BE PROCESSED DURING THIS STEP:
C
C IF IOWIOF = 0 -->  PROCESS INTRVL ONLY
C IF IOWIOF = 1 -->  PROCESS INTRVL AND PRECEEDING INTERVALS
C IF IOWIOF = 2 -->  PROCESS ALL INTERVALS
C
C IF IOWIOF = 0 -->  IF CURRENT DAY (IDAY) IS EARLIER THAN EPOCH DAY
C                    (IEPDAY), THEN REJECT POINT
C
      IF((IOWIOF.EQ.0).AND.(IDAY.LT.IEPDAY)) GO TO 100
C
C DETERMINE RELATIVE TIME OF DATA POINT (ICTIME) WITH RESPECT TO
C BEGINNING OF EPOCH DAY (IEPDAY), THEN DETERMINE ITS TIME INTERVAL (NI)
C WITH RESPECT TO INTERVAL WIDTH (INCREM).
C
      ICTIME=(IDAY-IEPDAY)*86400+IETIME
      NI=INT(ICTIME/INCREM)+1
C
C IF IOWIOF = 0 -->  IF CURRENT TIME INTERVAL IS LESS THAN INTERVAL OF
C                    INTEREST, THEN REJECT POINT
C
      IF((IOWIOF.EQ.0).AND.(NI.LT.INTRVL)) GO TO 100
C
C IF IOWIOF = 0 OR 1 -->  IF CURRENT TIME INTERVAL IS GREATER THAN
C                         INTERVAL OF INTEREST, THEN REJECT POINT
C
      IF((IOWIOF.LE.1).AND.(NI.GT.INTRVL)) GO TO 115
C
C BEGIN COUNT OF DATA ACCEPTED FROM UNIT IOW
C
      NTOTR=NTOTR+1
C
C UPDATE QUALITY CLASSIFICATION COUNTS OF IOW INPUT AND IOF OUTPUT DATA
C
      KCLASS(1,INOTE+1)=KCLASS(1,INOTE+1)+1
C
C PERFORM TRANSFORMATION FROM TOPOCENTRIC TO FIT/MAGSAT TO THE DESIRED
C SPACECRAFT COORDINATE SYSTEMS IN THE FOLLOWING ORDER:
C
C FOR IDIR = -1 OR 1:      TOPOCENTRIC     FIT/MAGSAT       DESIRED
C
C (1) OBSERVED COMPONENTS:  (TX,TY,TZ) --> (PX,PY,PZ) --> (UX,UY,UZ)
C (2) RESIDUAL COMPONENTS:  (DX,DY,DZ) --> (HX,HY,HZ) --> (WX,WY,WZ)
C
C
C FOR IDIR = 0:             FIT/MAGSAT     FIT/MAGSAT       DESIRED
C
C (1) OBSERVED COMPONENTS:  (BX,BY,BZ) --> (PX,PY,PZ) --> (UX,UY,UZ)
C (2) RESIDUAL COMPONENTS:  ( 0, 0, 0) --> ( 0, 0, 0) --> ( 0, 0, 0)
C
      IF(IDIR.NE.0) CALL BTTOBS(GCLAT,IDIR,TX,TY,TZ,PX,PY,PZ,PB,
```

```
     *                               UX,UY,UZ,UB)
      IF(IDIR.EQ.0) CALL BTTOBS(GCLAT,IDIR,BX,BY,BZ,PX,PY,PZ,PB,
     *                               UX,UY,UZ,UB)
      CALL BTTOBS(GCLAT,IDIR,DX,DY,DZ,HX,HY,HZ,HB,WX,WY,WZ,WB)
C
C IF CURRENT DATA POINT IS A TIME-GAP PADDED VALUE (INOTE = 2), THEN:
C
C OMIT FROM  -->  BINARY UNIT IOB FINAL OUTPUT TAPE
C INCLUDE IN -->  FORMATTED UNIT IOF FINAL OUTPUT TAPE
C
      IF(INOTE.EQ.2) GO TO 105
C
C UPDATE QUALITY CLASSIFICATION COUNTS OF UNIT IOB FIT/MAGSAT OUTPUT
C
      KCLASS(2,INOTE+1)=KCLASS(2,INOTE+1)+1
      NFIT=NFIT+1
C
C STORE CURRENT DATA POINT INFORMATION, RECORD II OF CURRENT 100 RECORD
C BLOCK, IN COLUMN II OF STORAGE ARRAYS A AND IA ACCORDING TO THE FIT
C INPUT FORMAT:
C
C     IA(1,II)  = MODIFIED JULIAN DAY
C     IA(2,II)  = MILLISECONDS OF DAY
C     A(3,II)   = NOT USED
C     A(4,II)   = FRACTION OF DAY
C     A(5,II)   = TIME IN YEARS FROM 1900
C     A(6,II)   = GEOCENTRIC LATITUDE
C     A(7,II)   = LONGITUDE
C     A(8,II)   = NOT USED
C     A(9,II)   = NOT USED
C     A(10,II)  = NOT USED
C     A(11,II)  = SATELLITE X-AXIS COMPONENT IN FIT/MAGSAT COORDINATES
C     A(12,II)  = SATELLITE Y-AXIS COMPONENT IN FIT/MAGSAT COORDINATES
C     A(13,II)  = SATELLITE Z-AXIS COMPONENT IN FIT/MAGSAT COORDINATES
C     A(14,II)  = SCALAR INTENSITY
C     IA(15,II) = GEOCENTRIC ALTITUDE (METERS) ABOVE ERAD (KM)
C     A(16,II)  = NOT USED
C     A(17,II)  = NOT USED
C     IA(18,II) = DATA QUALITY CLASSIFICATION FLAG (INOTE)
C     IA(19,II) = 0
C     IA(20,II) = SATELLITE VELOCITY VECTOR DIRECTION (IDIR)
C     IA(21,II) = 0
C     IA(22,II) = MAGNETIC LATITUDE OUTLIER FLAG FOR SATELLITE X-AXIS
C     IA(23,II) = MAGNETIC LATITUDE OUTLIER FLAG FOR SATELLITE Y-AXIS
C     IA(24,II) = MAGNETIC LATITUDE OUTLIER FLAG FOR SATELLITE Z-AXIS
C     IA(25,II) = MAGNETIC LATITUDE OUTLIER FLAG FOR SCALAR INTENSITY
C     A(26,II)  = NOT USED
C     A(27,II)  = NOT USED
C     A(28,II)  = NOT USED
C
C ASSIGN ARRAYS A AND IA NOW FOR CURRENT RECORD II
C
      IA(1,II)=IDAY
      IA(2,II)=IETIME*1000
      A(4,II)=REAL(IETIME)/86400.0
      A(5,II)=REAL(IYR)+(REAL(IDAY)+A(4,II))/365.0
      A(6,II)=GCLAT
      A(7,II)=GLON
      A(11,II)=PX
      A(12,II)=PY
```

```
      A(13,II)=PZ
      A(14,II)=PB
      IA(15,II)=INT((CALT-ERAD)*1000.0)
      IA(18,II)=INOTE
      IA(20,II)=IDIR
C
C CHECK MAGNETIC LATITUDE AGAINST GIVEN MAGNETIC LATITUDE TOLERANCE
C WINDOW FOR EACH VECTOR AND SCALAR COMPONENT USING THE FOLLOWING FLAGS:
C
C IF OUTSIDE WINDOW -->  IA = 0
C IF INSIDE WINDOW  -->  IA = 2
C
C OUTLIER COUNTER DEFINITIONS FOR INDIVIDUAL DATA QUALITY FLAGS:
C
C NOUTX(I)  COUNTS TOTAL FIT/MAGSAT X MAGNETIC LATITUDE OUTLIERS
C NOUTY(I)  COUNTS TOTAL FIT/MAGSAT Y MAGNETIC LATITUDE OUTLIERS
C NOUTZ(I)  COUNTS TOTAL FIT/MAGSAT Z MAGNETIC LATITUDE OUTLIERS
C NOUTB(I)  COUNTS TOTAL FIT/MAGSAT B MAGNETIC LATITUDE OUTLIERS
C NRCOUT(I) COUNTS TOTAL RECORDS WHICH HAVE AT LEAST ONE COMPONENT
C           OUTSIDE THE MAGNETIC LATITUDE TOLERANCE LEVEL
C
C (WHERE I = 1-8 CORRESPONDS TO INOTE = 0-7)
C
      AGMLAT=ABS(GMLAT)
C
C ASSIGN MAGNETIC OUTLIER FLAGS
C
      IF(AGMLAT.LE.XWINDO) IA(22,II)=2
      IF(AGMLAT.LE.YWINDO) IA(23,II)=2
      IF(AGMLAT.LE.ZWINDO) IA(24,II)=2
      IF(AGMLAT.LE.BWINDO) IA(25,II)=2
C
C UPDATE MAGNETIC LATITUDE OUTLIER RECORD COUNTS
C
      IF((AGMLAT.GT.XWINDO).OR.(AGMLAT.GT.YWINDO).OR.(AGMLAT.GT.ZWINDO)
     *.OR.(AGMLAT.GT.BWINDO)) NRCOUT(INOTE+1)=NRCOUT(INOTE+1)+1
C
C UPDATE MAGNETIC LATITUDE OUTLIER COMPONENT COUNTS
C
      IF(AGMLAT.GT.XWINDO) NOUTX(INOTE+1)=NOUTX(INOTE+1)+1
      IF(AGMLAT.GT.YWINDO) NOUTY(INOTE+1)=NOUTY(INOTE+1)+1
      IF(AGMLAT.GT.ZWINDO) NOUTZ(INOTE+1)=NOUTZ(INOTE+1)+1
      IF(AGMLAT.GT.BWINDO) NOUTB(INOTE+1)=NOUTB(INOTE+1)+1
C
C ENTRY POINT HERE IF CURRENT POINT IS PADDED TIME-GAP VALUE
C
  105 IF(IBTBS.NE.2) GO TO 110
C
C IF IBTBS = 2, THEN WRITE CURRENT DATA POINT INFORMATION TO UNIT IOD
C IN THE DESIRED SPACECRAFT COORDINATES
C
      NSAT=NSAT+1
      WRITE(IOD,206) IYR,IDAY,IETIME,GLAT,GCLAT,GLON,GMLAT,GMLON,ALT,
     *CALT,UX,UY,UZ,UB,WX,WY,WZ,WB,TX,TY,TZ,TB,DX,DY,DZ,DB,CX,CY,CZ,CB,
     *IDIR,INOTE,(IA(IFS(KK),II),KK=1,4)
C
C WRITE CURRENT DATA POINT INFORMATION TO UNIT IOF IN THE FIT/MAGSAT
C COORDINATES, INCLUDING DATA FLAGS FOR THE INDIVIDUAL COMPONENTS
C
  110 WRITE(IOF,206) IYR,IDAY,IETIME,GLAT,GCLAT,GLON,GMLAT,GMLON,ALT,
```

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     *CALT,PX,PY,PZ,PB,HX,HY,HZ,HB,TX,TY,TZ,TB,DX,DY,DZ,DB,CX,CY,CZ,CB,
     *IDIR,INOTE,(IA(KK,II),KK=22,25)
C
C IF CURRENT POINT IS PADDED TIME-GAP VALUE, THEN READ NEXT RECORD ON
C UNIT IOW, BUT DO NOT PROGRESS TO NEXT RECORD OF DATA BLOCK A
C
      IF(INOTE.EQ.2) GO TO 100
C
C IF CURRENT POINT IS NOT A TIME-GAP VALUE, THEN PROGRESS TO NEXT
C RECORD OF DATA BLOCK A
C
   95 CONTINUE
C
C WRITE FULL 100 RECORD DATA BLOCK TO BINARY UNIT IOB
C
      NBLK=NBLK+1
      WRITE(IOB) A
      IF(NBLK.GT.1) GO TO 85
C
C DETERMINE NUMBER OF NON-ZERO (NOZERO) AND PADDED-ZERO (NPAD) RECORDS
C THAT OCCURRED ON LAST 100-RECORD BLOCK OF UNIT IOB PRIOR TO THIS RUN
C
      NPAD=101-NSTART
      NOZERO=NSTART-1
C
C SET RECORD APPEND POSITION TO NSTART = 1 FOR BLOCKS SUBSEQUENT TO THE
C FIRST BLOCK SO THAT A FULL 100 RECORDS MAY BE WRITTEN TO THEM
C
      NSTART=1
      GO TO 85
C
C WRITE FINAL PARTIAL 100 RECORD DATA BLOCK TO BINARY UNIT IOB
C
  115 NBLK=NBLK+1
      WRITE(IOB) A
C
C CALCULATE TOTAL NUMBER OF COMPONENTS (NCOMPF) OUTPUT BY THE FILTER
C EXCLUDING PADDED TIME-GAP RECORDS
C
      NCOMPF=4*(NTOTR-KCLASS(1,3))
C
C PRINT QUALITY CLASSIFICATION STATUS OF UNIT IOF FIT/MAGSAT OUTPUT
C
      WRITE(6,207) IOF
  207 FORMAT(//1X,'<STEP5 FIT/MAGSAT FORMATTED OUTPUT DATA CLASSIFICATIO
     *N ON UNIT ',I2,'>')
      WRITE(6,204) (KCLASS(1,KCL),KCL=1,8),NTOTR,NCOMPF
C
C PRINT QUALITY CLASSIFICATION STATUS OF UNIT IOB FIT/MAGSAT OUTPUT
C
      WRITE(6,208) IOB
  208 FORMAT(//1X,'<STEP5 FIT/MAGSAT BINARY OUTPUT DATA CLASSIFICATION O
     *N UNIT ',I2,'>')
      WRITE(6,204) (KCLASS(2,KCL),KCL=1,8),NFIT,NCOMPF
C
C PRINT WRITTEN RECORD TOTALS FOR EACH OUTPUT DATA SET TYPE
C
      WRITE(6,209) NTOTR,IOF,NSAT,IOD,NFIT,IOB,NBLK,IOB
  209 FORMAT(//1X,'OUTPUT RECORD SUMMARY:'//1X,'TOTAL ====>  ',I5,' FORM
     *ATTED FIT/MAGSAT RECORDS WRITTEN TO UNIT ',I2//1X,'TOTAL ====>  ',
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```
     *I5,' FORMATTED DESIRED RECORDS WRITTEN TO UNIT ',I2//1X,'TOTAL ===
     *=>  ',I5,' NON-ZERO PADDED RECORDS WRITTEN TO UNIT ',I2//1X,'TOTAL
     * ====>  ',I5,' BINARY 100-RECORD BLOCKS WRITTEN TO UNIT ',I2/)
C
C PRINT NUMBER OF PADDED RECORDS OVERWRITTEN (BY DATA GENERATED IN THIS
C RUN) AND NUMBER OF RECORDS ALREADY EXISTING ON FIRST 100-RECORD DATA
C BLOCK TRANSMITTED TO UNIT IOB DURING THIS RUN
C
      WRITE(6,210) NOZERO,NPAD
  210 FORMAT(20X,'TOTAL ====>  ',I5,' PREVIOUSLY EXISTING RECORDS INCORP
     *ORATED IN FIRST 100-RECORD DATA BLOCK'//20X,'TOTAL ====>  ',I5,' R
     *ECORDS GENERATED DURING THIS INTERVAL INCORPORATED IN FIRST 100-RE
     *CORD DATA BLOCK'/)
C
C PRINT MAGNETIC LATITUDE OUTLIER HEADING
C
      WRITE(6,211)
  211 FORMAT(//1X,'MAGNETIC LATITUDE OUTLIER BREAKDOWN BY FLAGS:'//6X,'F
     *LAG',10X,'X OUTLIERS',4X,'Y OUTLIERS',4X,'Z OUTLIERS',4X,'B OUTLIE
     *RS',6X,'COMPONENTS',4X,'RECORDS'/)
C
C MAGNETIC LATITUDE OUTLIER COUNTER DEFINITIONS:
C
C NXO    COUNTS TOTAL NUMBER OF MAGNETIC LATITUDE X OUTLIERS
C NYO    COUNTS TOTAL NUMBER OF MAGNETIC LATITUDE Y OUTLIERS
C NZO    COUNTS TOTAL NUMBER OF MAGNETIC LATITUDE Z OUTLIERS
C NBO    COUNTS TOTAL NUMBER OF MAGNETIC LATITUDE B OUTLIERS
C NCO    COUNTS TOTAL NUMBER OF MAGNETIC LATITUDE OUTLIER COMPONENTS
C NFOUT  COUNTS TOTAL NUMBER OF MAGNETIC LATITUDE OUTLIERS FOR
C        PARTICULAR DATA QUALITY FLAG
C NRCTOT COUNTS TOTAL NUMBER OF RECORDS CONTAINING MAGNETIC LATITUDE
C        OUTLIERS
C
      NXO=0
      NYO=0
      NZO=0
      NBO=0
      NRCTOT=0
C
C PRINT MAGNETIC LATITUDE OUTLIER COUNTS PER EACH DATA QUALITY FLAG
C
      DO 120 IN=1,8
      NF=IN-1
      NXO=NXO+NOUTX(IN)
      NYO=NYO+NOUTY(IN)
      NZO=NZO+NOUTZ(IN)
      NBO=NBO+NOUTB(IN)
      NRCTOT=NRCTOT+NRCOUT(IN)
      NFOUT=NOUTX(IN)+NOUTY(IN)+NOUTZ(IN)+NOUTB(IN)
  120 WRITE(6,212) NF,NOUTX(IN),NOUTY(IN),NOUTZ(IN),NOUTB(IN),NFOUT,
     *NRCOUT(IN)
  212 FORMAT(1X,'INOTE = ',I1,' -->  ',4I14,' -->  ',5X,I5,6X,I5)
C
C NCO COUNTS TOTAL NUMBER OF MAGNETIC LATITUDE OUTLIER COMPONENTS
C
      NCO=NXO+NYO+NZO+NBO
C
C PRINT MAGNETIC LATITUDE OUTLIER COUNTS PER EACH COMPONENT
C
      WRITE(6,213) NXO,NYO,NZO,NBO,NCO,NRCTOT
```

```
  213 FORMAT(/1X,'TOTAL      -->  ',4I14,' ==>  ',5X,I5,6X,I5///)
C
C BEGIN PROCESSING STATUS ON ENTIRE DATA SETS EXISTING ON UNITS IOF,
C IOD, AND IOB
C
C ADJUST OUTPUT UNIT CLASSIFICATION COUNTS DUE TO NEWLY APPENDED DATA
C
      NRIOF=NRIOF+NTOTR
      NRIOD=NRIOD+NSAT
      DO 125 IADD=1,8
      KCLASS(3,IADD)=KCLASS(3,IADD)+KCLASS(1,IADD)
  125 KCLASS(4,IADD)=KCLASS(4,IADD)+KCLASS(1,IADD)
C
C CALCULATE TOTAL NUMBER OF COMPONENTS (NCOMPT) EXISTING ON UNIT IOF
C EXCLUDING PADDED TIME-GAP RECORDS
C
      NCOMPT=4*(NRIOF-KCLASS(3,3))
C
C PRINT STATUS OF ENTIRE OUTPUT DATA SET EXISTING ON UNIT IOF
C
      WRITE(6,214) IOF
  214 FORMAT(//1X,'<TOTAL FIT/MAGSAT FORMATTED OUTPUT DATA CLASSIFICATIO
     *N EXISTING ON UNIT ',I2,'>')
      WRITE(6,204) (KCLASS(3,KCL),KCL=1,8),NRIOF,NCOMPT
C
C CALCULATE TOTAL NUMBER OF 100-RECORD BLOCKS EXISTING ON UNIT IOB
C AFTER APPENDING NEW DATA AND ELIMINATING PADDED ZEROS
C
      NBIOB=NBIOB+NFIT
      NBLK=INT(NBIOB/100)
      IF(MOD(NBIOB,100).GT.0) NBLK=NBLK+1
C
C ADJUST UNIT IOB OUTPUT DATA QUALITY CLASSIFICATION STATUS BY OMITTING
C PADDED TIME-GAP VALUE COUNTS STORED IN KCLASS(3,3)
C
      KCLASS(3,3)=0
C
C PRINT STATUS OF ENTIRE OUTPUT DATA SET EXISTING ON UNIT IOB
C
      WRITE(6,215) IOB
  215 FORMAT(//1X,'<TOTAL FIT/MAGSAT BINARY OUTPUT DATA CLASSIFICATION E
     *XISTING ON UNIT ',I2,'>')
      WRITE(6,204) (KCLASS(3,KCL),KCL=1,8),NBIOB,NCOMPT
C
C PRINT WRITTEN RECORD TOTALS FOR EACH OUTPUT DATA SET TYPE
C
      WRITE(6,209) NRIOF,IOF,NRIOD,IOD,NBIOB,IOB,NBLK,IOB
C
C PRINT MAGNETIC LATITUDE OUTLIER HEADING
C
      WRITE(6,211)
C
C MAGNETIC LATITUDE OUTLIER COUNTER DEFINITIONS:
C
C NXO-NRCTOT ARE ANALOGOUS FOR THIS TOTAL OUTPUT STATUS OF UNIT IOF
C (SEE DESCRIPTION ABOVE) THESE ARE CUMULATIVE SUMS FROM THE PRESENT
C FILTER OUTPUT COUNTS AND THE COUNTS MADE ON DATA WHICH EXISTED PRIOR
C TO THIS RUN ON UNIT IOF
C
C PRINT MAGNETIC LATITUDE OUTLIER COUNTS PER EACH DATA QUALITY FLAG
```

```
C
      DO 130 IN=1,8
      NF=IN-1
      NRCTOT=NRCTOT+NRCOLD(IN)
      NRCOLD(IN)=NRCOLD(IN)+NRCOUT(IN)
      NXO=NXO+NOLDX(IN)
      NYO=NYO+NOLDY(IN)
      NZO=NZO+NOLDZ(IN)
      NBO=NBO+NOLDB(IN)
      NOLDX(IN)=NOLDX(IN)+NOUTX(IN)
      NOLDY(IN)=NOLDY(IN)+NOUTY(IN)
      NOLDZ(IN)=NOLDZ(IN)+NOUTZ(IN)
      NOLDB(IN)=NOLDB(IN)+NOUTB(IN)
      NFOUT=NOLDX(IN)+NOLDY(IN)+NOLDZ(IN)+NOLDB(IN)
  130 WRITE(6,212) NF,NOLDX(IN),NOLDY(IN),NOLDZ(IN),NOLDB(IN),NFOUT,
     *NRCOLD(IN)
C
C NCO COUNTS TOTAL NUMBER OF MAGNETIC LATITUDE OUTLIER COMPONENTS
C
      NCO=NXO+NYO+NZO+NBO
C
C PRINT MAGNETIC LATITUDE OUTLIER COUNTS PER EACH COMPONENT
C
      WRITE(6,213) NXO,NYO,NZO,NBO,NCO,NRCTOT
C
C PRINT STATUS OF ENTIRE OUTPUT DATA SET EXISTING ON UNIT IOD ONLY IF
C DESIRED SPACECRAFT OUTPUT WAS PRODUCED DURING THIS RUN (IBTBS = 2)
C
      IF(IBTBS.NE.2) RETURN
C
C CALCULATE TOTAL NUMBER OF COMPONENTS (NCOMPD) EXISTING ON UNIT IOD
C EXCLUDING PADDED TIME-GAP RECORDS
C
      NCOMPD=4*(NRIOD-KCLASS(4,3))
C
C PRINT STATUS OF ENTIRE OUTPUT DATA SET EXISTING ON UNIT IOD
C
      WRITE(6,216) IOD
  216 FORMAT(//1X,'<TOTAL DESIRED SPACECRAFT FORMATTED OUTPUT DATA CLASS
     *IFICATION EXISTING ON UNIT ',I2,'>')
      WRITE(6,204) (KCLASS(4,KCL),KCL=1,8),NRIOD,NCOMPD
      RETURN
      END
      SUBROUTINE BTTOBS(GCLAT,IDIR,EX,EY,EZ,FX,FY,FZ,FB,SX,SY,SZ,SB)
C
C SUBROUTINE TO TRANSFORM MAGNETIC FIELD COMPONENTS FROM TOPOCENTRIC
C TO FIT/MAGSAT SPACECRAFT-FIXED TO DESIRED SPACECRAFT-FIXED BY
C PERFORMING:
C
C                    BS=RC*ST*BT
C
C WHERE BS = FIELD COMPONENTS IN DESIRED SPACECRAFT COORDINATES
C       RC = ROTATION MATRIX FROM FIT/MAGSAT TO BS COORDINATES
C       ST = ROTATION MATRIX FROM GEOCENTRIC TO FIT/MAGSAT COORDINATES
C       BT = FIELD COMPONENTS IN CARTESIAN TOPOCENTRIC COORDINATES
C
C MATRIX ST = TS' HAS THE FOLLOWING FORM:
C
C       ST = (  SIN(ALPHA)/COS(GCLAT)  #COS(ALPHA)*SIN(DELTA)   0 )
C            (            0                       0             1 )
```

```
C              ( #COS(ALPHA)*SIN(DELTA)  -SIN(ALPHA)/COS(GCLAT)   0 )
C
C WHERE TS'   = INVERSE OF MATRIX TS = TRANSPOSE OF MATRIX TS
C        ALPHA = NEGATIVE COMPLEMENT OF ORBIT INCLINATION
C        GCLAT = GEOCENTRIC LATITUDE
C        DELTA = ARCOS(TAN(GCLAT)*TAN(ALPHA))
C        #     = + FOR ASCENDING AND - FOR DESCENDING SATELLITE DATA
C
C BS = (SX,SY,SZ) WHERE SX, SY, AND SZ ARE THE DESIRED SPACECRAFT
C      COMPONENTS
C
C BT = (EX,EY,EZ) WHERE EX, EY, AND EZ ARE THE CONVENTIONAL TOPOCENTRIC
C      COMPONENTS, THAT IS, (-BTHETA, BPHI, -BRHO)
C
      REAL*8 COSLAT,SINALP,COSALP,SINDEL,SADCL,CAMSD,DTR
      DIMENSION EU(3),CA(3,3),QI(3),QF(3),CF(3),RF(3,3),RC(3,3)
      COMMON /EPHEMS/ ORBINC,ERAD,IEPDAY,INCREM,INTRVL
      COMMON /COTRAN/ EU,CA,QI,QF,CF,RF,RC
C
C CALCULATE DEGREES-TO-RADIANS CONVERSION
C
      DTR=3.141592653D0/180.D0
C
C IF SATELLITE VELOCITY DIRECTION IS INDETERMINABLE (IDIR = 0), THEN
C NO TOPOCENTRIC COMPONENTS HAVE BEEN CALCULATED. SIMPLY USE ORIGINAL,
C UNMODIFIED COMPONENTS IN FIT/MAGSAT COORDINATES DETERMINED IN STEP1
C AS THE OUTPUT FIELD COMPONENTS IN STEP5 BY PERFORMING:
C
C                  FS=BT
C
C BT = (EX,EY,EZ) WHERE EX, EY, AND EZ ARE THE ORIGINAL, UNMODIFIED
C      FIT/MAGSAT COMPONENTS
C
      IF(IDIR.NE.0) GO TO 10
      FX=EX
      FY=EY
      FZ=EZ
      GO TO 20
C
C SATELLITE VELOCITY DIRECTION HAS BEEN DETERMINED AND TOPOCENTRIC FIELD
C COMPONENTS HAVE BEEN GENERATED FOR THIS DATA POINT
C
C PERFORM:         FS=ST*BT
C
C FS = (FX,FY,FZ) WHERE FX, FY, AND FZ ARE THE FIT/MAGSAT SPACECRAFT
C      COMPONENTS, WHICH ARE PASSED BACK TO STEP5 FOR FURTHER USE
C
C DETERMINE NEGATIVE COMPLEMENT ALPHA OF ORBIT INCLINATION ANGLE ORBINC
C
   10 ALPHA=ORBINC-90.0
C
C DETERMINE NEEDED TRIGONOMETRIC FUNCTIONS OF GCLAT, ALPHA, AND DELTA
C
      COSLAT=DCOS(DBLE(GCLAT)*DTR)
      SINALP=DSIN(DBLE(ALPHA)*DTR)
      COSALP=DCOS(DBLE(ALPHA)*DTR)
      SINDEL=DSIN(DACOS(DTAN(DBLE(GCLAT)*DTR)*DTAN(DBLE(ALPHA)*DTR)))
      SADCL=SINALP/COSLAT
      CAMSD=COSALP*SINDEL
      IF(IDIR.EQ.-1) GO TO 30
```

```
C
C PERFORM TRANSFORMATION IF SATELLITE IS ASCENDING
C
      FX=EX*SADCL+EY*CAMSD
      FZ=EX*CAMSD-EY*SADCL
      GO TO 40
C
C PERFORM TRANSFORMATION IF SATELLITE IS DESCENDING
C
   30 FX=EX*SADCL-EY*CAMSD
      FZ=-EX*CAMSD-EY*SADCL
   40 FY=EZ
C
C PERFORM:          BS=RC*FS
C
   20 SX=RC(1,1)*FX+RC(1,2)*FY+RC(1,3)*FZ
      SY=RC(2,1)*FX+RC(2,2)*FY+RC(2,3)*FZ
      SZ=RC(3,1)*FX+RC(3,2)*FY+RC(3,3)*FZ
C
C COMPUTE SCALAR FIELD VALUES IN BOTH FIT/MAGSAT AND DESIRED SPACECRAFT
C COORDINATES
C
      FB=SQRT(FX*FX+FY*FY+FZ*FZ)
      SB=SQRT(SX*SX+SY*SY+SZ*SZ)
      RETURN
      END
```

```
      SUBROUTINE BSPLYN(TS,TF,N,H,T,ICOV,ICOR,NDCOVM,INTERP,NDERV,ISHOW,
     *IPRINT,INTV,KNTADJ,ITERMX,LGRMAX,EPS,NOBS,KO,EKNOTS,FREQ,X,S,SIG,
     *V,COEF,D,WTRMS,GSIG,RESID,XINTRP)
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION X(500),S(500),COEF(500),KSKIP(500),ELAM(500),D(13000)
      DIMENSION V(5,500),EKNOTS(500),SIG(500),GSIG(5,500),RESID(500)
      DIMENSION FREQ(500)
      INTEGER H,H2N,T
      LDV=1
      LCV=0
      LDC=1
      LCR=0
      NSHOW=0
      NPRINT=0
      MH=H
      IF(N.EQ.0) H=0
      IF(N.LT.1) GO TO 38
      NM1=N-1
      IF(NDERV.LE.NM1) GO TO 38
      WRITE(6,274) NM1
 274  FORMAT(1X,'**** ATTENTION:  NDERV MUST NOT EXCEED ',I2,' ****')
      STOP
 38   DO 1 I=1,N
      ELAM(I)=TS
 1    ELAM(N+H+I)=TF
      DO 50 II=1,H
 50   ELAM(II+N)=EKNOTS(II)
      DO 800 NEX=1,H
 800  KSKIP(NEX)=0
      KS=KO
      IDIV=10
 801  KNUM=MOD(KS,IDIV)
      KS=KS/IDIV
      IF(KNUM.EQ.0) IDIV=IDIV*10
      IF(KNUM.NE.0) KSKIP(KNUM)=1
      IF(KS.EQ.0) GO TO 802
      GO TO 801
 802  NDERVP=NDERV+1
      NDCVMP=NDCOVM+1
      IPARM=N+H
      H2N=IPARM+N
      NPARM=IPARM+2*T
      IF((IPARM.EQ.0).AND.(T.NE.0)) NPARM=NPARM+1
      NOPP=NPARM+2
      NP1=N+1
      IF(NDERV.GE.NDCOVM) GO TO 25
      WRITE(6,330) NDERV
 330  FORMAT(1X,'**** ATTENTION:  NDCOVM MUST NOT EXCEED ',I2,' ****')
      STOP
 25   IF(NPARM.LE.NOBS) GO TO 26
      WRITE(6,331) NPARM,NOBS
 331  FORMAT(1X,'**** ATTENTION:  NUMBER OF PARAMETERS ',I5,' EXCEEDS AM
     *OUNT OF DATA ',I5,' ****')
      STOP
 26   IF(INTERP.EQ.1) GO TO 470
      IF((ISHOW.EQ.0).OR.(ISHOW.EQ.3)) GO TO 710
      WRITE(6,23) TS,N,ICOV,NDCOVM,NDERV,IPRINT,ITERMX,NOBS,TF,MH,
     *ICOR,INTERP,ISHOW,KNTADJ,LGRMAX,EPS,KO,T,INTV
 23   FORMAT(/1X,'B-SPLINE OUTPUT .....'//1X,'PARAMETERS:'//1X,'TS = ',F
     *15.8,'   N = ',I3,'   ICOV = ',I3,'   NDCOVM = ',I3,'   NDERV = ',
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```
     *I3,'   IPRINT = ',I3,'   ITERMX = ',I3,'   NOBS = ',I5/1X,'TF = ',
     *F15.8,'   H = ',I3,'   ICOR = ',I3,'   INTERP = ',I3,'   ISHOW = '
     *,I3,'   KNTADJ = ',I3,'   LGRMAX = ',I3,'   EPS = ',F6.4/1X,'KO =
     *',I15,'   T = ',I3,'   INTV = ',I3//1X,'RAW DATA .....'//3X,'OBS',
     *11X,'X VALUE',19X,'F(X)',13X,'SIGMA'//)
      DO 69 II=1,NOBS
69    WRITE(6,678) II,X(II),S(II),SIG(II)
678   FORMAT(1X,I5,3X,F15.8,3X,F20.10,3X,F15.8)
      IF(T.NE.0) WRITE(6,604)
604   FORMAT(//3X,'NUM',7X,'A PRIORI FIT FREQUENCY'//)
      DO 33 II=1,T
33    WRITE(6,626) II,FREQ(II)
626   FORMAT(1X,I5,14X,F15.8)
      IF(H2N.NE.0) WRITE(6,677)
677   FORMAT(//3X,'NUM',7X,'ORIGINAL KNOT POSITION'//)
      DO 66 II=1,H2N
66    WRITE(6,676) II,ELAM(II)
676   FORMAT(1X,I5,14X,F15.8)
      IF(IPARM.EQ.0) GO TO 700
      CALL CALBSP(ELAM(NP1),NP1,ELAM,N,H,X,S,SIG,NOBS,V,LDV,LCV,LDC,LCR,
     *COEF,D,NPARM,NOPP,H2N,WTRMS,ISING,NP1,NSHOW,NPRINT,INTERP,GSIG,
     *RESID,XINTRP,FREQ,T,TS,INTV)
      WRITE(6,400) WTRMS
400   FORMAT(/1X,'WEIGHTED RMS OF FIT = ',F20.10)
710   IF(IPARM.EQ.0) GO TO 700
      IF(KNTADJ.EQ.0) GO TO 700
      DO 10 KITER=1,ITERMX
      DIFMAX=0.D0
      DO 20 IUV=NP1,IPARM
      IUVEC=IPARM-IUV+NP1
      IF(KSKIP(IUVEC-N).EQ.1) GO TO 20
      VALMIN=ELAM(IUVEC-1)
      VALMAX=ELAM(IUVEC+1)
      BPT=ELAM(IUVEC)
      IF(IUVEC.NE.NP1) GO TO 100
110   VALMIN=VALMIN+EPS
      CALL CALBSP(VALMIN,IUVEC,ELAM,N,H,X,S,SIG,NOBS,V,LDV,LCV,LDC,LCR,
     *COEF,D,NPARM,NOPP,H2N,FVMIN,ISING,NP1,NSHOW,NPRINT,INTERP,GSIG,
     *RESID,XINTRP,FREQ,T,TS,INTV)
      IF(ISING.EQ.1) GO TO 110
100   IF(IUVEC.NE.IPARM) GO TO 120
130   VALMAX=VALMAX-EPS
      CALL CALBSP(VALMAX,IUVEC,ELAM,N,H,X,S,SIG,NOBS,V,LDV,LCV,LDC,LCR,
     *COEF,D,NPARM,NOPP,H2N,FVMAX,ISING,NP1,NSHOW,NPRINT,INTERP,GSIG,
     *RESID,XINTRP,FREQ,T,TS,INTV)
      IF(ISING.EQ.1) GO TO 130
120   DPAST=BPT
      CALL CALBSP(BPT,IUVEC,ELAM,N,H,X,S,SIG,NOBS,V,LDV,LCV,LDC,LCR,
     *COEF,D,NPARM,NOPP,H2N,FBPT,ISING,NP1,NSHOW,NPRINT,INTERP,GSIG,
     *RESID,XINTRP,FREQ,T,TS,INTV)
      DOLD=FBPT
      STEP=10.D0*EPS
140   VALHI=BPT+STEP
      IF(VALHI.LT.VALMAX) GO TO 150
      CPT=VALMAX
      IF(IUVEC.EQ.IPARM) GO TO 145
      CALL CALBSP(CPT,IUVEC,ELAM,N,H,X,S,SIG,NOBS,V,LDV,LCV,LDC,LCR,
     *COEF,D,NPARM,NOPP,H2N,FCPT,ISING,NP1,NSHOW,NPRINT,INTERP,GSIG,
     *RESID,XINTRP,FREQ,T,TS,INTV)
      GO TO 160
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145  FCPT=FVMAX
     GO TO 160
150  CALL CALBSP(VALHI,IUVEC,ELAM,N,H,X,S,SIG,NOBS,V,LDV,LCV,LDC,LCR,
    *COEF,D,NPARM,NOPP,H2N,DNEW,ISING,NP1,NSHOW,NPRINT,INTERP,GSIG,
    *RESID,XINTRP,FREQ,T,TS,INTV)
     IF(DNEW.GT.DOLD) GO TO 170
     DOLD=DNEW
     STEP=STEP+STEP
     GO TO 140
170  CPT=VALHI
     FCPT=DNEW
160  DOLD=FBPT
     STEP=10.D0*EPS
180  VALLO=BPT-STEP
     IF(VALLO.GT.VALMIN) GO TO 190
     APT=VALMIN
     IF(IUVEC.EQ.NP1) GO TO 195
     CALL CALBSP(APT,IUVEC,ELAM,N,H,X,S,SIG,NOBS,V,LDV,LCV,LDC,LCR,
    *COEF,D,NPARM,NOPP,H2N,FAPT,ISING,NP1,NSHOW,NPRINT,INTERP,GSIG,
    *RESID,XINTRP,FREQ,T,TS,INTV)
     GO TO 200
195  FAPT=FVMIN
     GO TO 200
190  CALL CALBSP(VALLO,IUVEC,ELAM,N,H,X,S,SIG,NOBS,V,LDV,LCV,LDC,LCR,
    *COEF,D,NPARM,NOPP,H2N,DNEW,ISING,NP1,NSHOW,NPRINT,INTERP,GSIG,
    *RESID,XINTRP,FREQ,T,TS,INTV)
     IF(DNEW.GT.DOLD) GO TO 210
     DOLD=DNEW
     STEP=STEP+STEP
     GO TO 180
210  APT=VALLO
     FAPT=DNEW
200  CALL LAGRAN(APT,BPT,CPT,DPT,ELAM,IUVEC,N,H,X,S,SIG,NOBS,V,LDV,LCV,
    *LDC,LCR,COEF,D,NPARM,H2N,EPS,LGRMAX,NOPP,NP1,FAPT,FBPT,FCPT,FDPT,
    *KITER,ISHOW,GSIG,RESID,XINTRP,FREQ,T,TS,INTV)
     DIFLAM=DABS(DPAST-DPT)
     ELAM(IUVEC)=DPT
     IF(DIFLAM.GT.DIFMAX) DIFMAX=DIFLAM
 20  CONTINUE
 10  IF(DIFMAX.LE.EPS) GO TO 30
     IF((ISHOW.EQ.1).OR.(ISHOW.EQ.2)) WRITE(6,119) ITERMX
119  FORMAT(//1X,'ADJUSTED KNOT POSITIONS ARE BEST FOR MAXIMUM ITERATIO
    *N NUMBER OF ',I2)
     GO TO 55
 30  IF((ISHOW.EQ.1).OR.(ISHOW.EQ.2)) WRITE(6,555) KITER
555  FORMAT(//1X,'ADJUSTED KNOT POSITIONS CONVERGED AFTER ',I2,' ITERAT
    *IONS')
 55  IF((ISHOW.EQ.0).OR.(ISHOW.EQ.3)) GO TO 700
     WRITE(6,122)
122  FORMAT(//3X,'NUM',7X,'ADJUSTED KNOT POSITION'//)
     DO 72 II=1,H2N
 72  WRITE(6,644) II,ELAM(II)
644  FORMAT(1X,I5,14X,F15.8)
     CALL CALBSP(ELAM(NP1),NP1,ELAM,N,H,X,S,SIG,NOBS,V,LDV,LCV,LDC,LCR,
    *COEF,D,NPARM,NOPP,H2N,WTRMS,ISING,NP1,NSHOW,NPRINT,INTERP,GSIG,
    *RESID,XINTRP,FREQ,T,TS,INTV)
     WRITE(6,400) WTRMS
700  CALL CALBSP(ELAM(NP1),NP1,ELAM,N,H,X,S,SIG,NOBS,V,NDERVP,ICOV,
    *NDCVMP,ICOR,COEF,D,NPARM,NOPP,H2N,FLAST,ISING,NP1,ISHOW,IPRINT,
    *INTERP,GSIG,RESID,XINTRP,FREQ,T,TS,INTV)
```

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      DO 40 II=1,H
 40   EKNOTS(II)=ELAM(II+N)
      RETURN
470   IF((ISHOW.EQ.1).OR.(ISHOW.EQ.3)) WRITE(6,520) XINTRP
520   FORMAT(/1X,'** B-SPLINE INTERPOLATION:  X = ',F15.8,' **'/)
      CALL CALBSP(ELAM(NP1),NP1,ELAM,N,H,X,S,SIG,NOBS,V,NDERVP,ICOV,
     *NDCVMP,ICOR,COEF,D,NPARM,NOPP,H2N,FLAST,ISING,NP1,ISHOW,IPRINT,
     *INTERP,GSIG,RESID,XINTRP,FREQ,T,TS,INTV)
      RETURN
      END
      SUBROUTINE LAGRAN(APT,BPT,CPT,DPT,ELAM,IUVEC,N,H,X,S,SIG,NOBS,V,
     *LDV,LCV,LDC,LCR,COEF,D,NPARM,H2N,EPS,LGRMAX,NOPP,NP1,FAPT,FBPT,
     *FCPT,FDPT,KITER,ISHOW,GSIG,RESID,XINTRP,FREQ,T,TS,INTV)
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION X(500),S(500),COEF(500),ELAM(500),V(5,500),SIG(500)
      DIMENSION D(13000),GSIG(5,500),RESID(500),FREQ(500)
      INTEGER H,H2N,T
      NSHOW=0
      NPRINT=0
      INTERP=0
      DO 1 ITER=1,LGRMAX
      DENOM=(BPT-CPT)*FAPT+(CPT-APT)*FBPT+(APT-BPT)*FCPT
      IF(DENOM.LT.0.D0) GO TO 50
      IF(FAPT.LT.FCPT) GO TO 10
      APT=BPT
      FAPT=FBPT
      BPT=(APT+CPT)/2.D0
      DOLD=BPT
      IF(DABS(CPT-BPT).GT.EPS) GO TO 2
      DPT=BPT
      RETURN
  2   CALL CALBSP(BPT,IUVEC,ELAM,N,H,X,S,SIG,NOBS,V,LDV,LCV,LDC,LCR,
     *COEF,D,NPARM,NOPP,H2N,FBPT,ISING,NP1,NSHOW,NPRINT,INTERP,GSIG,
     *RESID,XINTRP,FREQ,T,TS,INTV)
      GO TO 1
 10   CPT=BPT
      FCPT=FBPT
      BPT=(APT+CPT)/2.D0
      DOLD=BPT
      IF(DABS(BPT-APT).GT.EPS) GO TO 3
      DPT=BPT
      RETURN
  3   CALL CALBSP(BPT,IUVEC,ELAM,N,H,X,S,SIG,NOBS,V,LDV,LCV,LDC,LCR,
     *COEF,D,NPARM,NOPP,H2N,FBPT,ISING,NP1,NSHOW,NPRINT,INTERP,GSIG,
     *RESID,XINTRP,FREQ,T,TS,INTV)
      GO TO 1
 50   DPT=0.5D0*((BPT**2-CPT**2)*FAPT+(CPT**2-APT**2)*FBPT+(APT**2-
     *BPT**2)*FCPT)/DENOM
      IF(ITER.EQ.1) GO TO 4
      IF(DABS(DOLD-DPT).LE.EPS) RETURN
  4   DOLD=DPT
      CALL CALBSP(DPT,IUVEC,ELAM,N,H,X,S,SIG,NOBS,V,LDV,LCV,LDC,LCR,
     *COEF,D,NPARM,NOPP,H2N,FDPT,ISING,NP1,NSHOW,NPRINT,INTERP,GSIG,
     *RESID,XINTRP,FREQ,T,TS,INTV)
      IF(APT.LE.DPT.AND.DPT.LE.BPT) GO TO 5
      IF(BPT.LE.DPT.AND.DPT.LE.CPT) GO TO 6
      IF(DPT.LT.APT) GO TO 7
      IF(DPT.GT.CPT) GO TO 8
  5   IF(FDPT.LE.FBPT) GO TO 9
      APT=DPT
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      FAPT=FDPT
      GO TO 1
 9    CPT=BPT
      FCPT=FBPT
      BPT=DPT
      FBPT=FDPT
      GO TO 1
 6    IF(FDPT.LE.FBPT) GO TO 12
      CPT=DPT
      FCPT=FDPT
      GO TO 1
12    APT=BPT
      FAPT=FBPT
      BPT=DPT
      FBPT=FDPT
      GO TO 1
 7    DPT=APT
      FDPT=FAPT
      RETURN
 8    DPT=CPT
      FDPT=FCPT
      RETURN
 1    CONTINUE
      IF((ISHOW.EQ.1).OR.(ISHOW.EQ.2)) WRITE(6,100) LGRMAX,IUVEC,KITER
100   FORMAT(//1X,'WARNING:  LAGRANGIAN INTERPOLATION DID NOT CONVERGE W
     *ITHIN ',I2,' STEPS FOR KNOT NUMBER ',I2,' AT ITERATION ',I2)
      RETURN
      END
      SUBROUTINE CALBSP(PNT,IUVEC,ELAM,N,H,X,S,SIG,NOBS,V,NDERVP,ICOV,
     *NDCVMP,ICOR,COEF,D,NPARM,NOPP,H2N,WTRMS,ISING,NP1,ISHOW,IPRINT,
     *INTERP,GSIG,RESID,XINTRP,FREQ,T,TS,INTV)
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION F(500),X(500),S(500),COEF(500),RESID(500),IST(500)
      DIMENSION ELAM(500), DIAG(500),CSUM(500),FCT(500),GSIG(5,500)
      DIMENSION V(5,500),SIG(500),XARRAY(6,500,20),D(13000),G(13000)
      DIMENSION FREQ(500)
      INTEGER H,H2N,T
      INDX(NROW,NCOL,NDIM)=(NROW*(NDIM+NDIM+5-NROW))/2+NCOL-NDIM-2
      IPARM=H+N
      JPARM=NPARM-IPARM
      ELAM(IUVEC)=PNT
      IF(INTERP.EQ.1) GO TO 360
      MAXD=(NPARM*(NPARM+1))/2+2*NPARM
      DO 9 II=1,MAXD
 9    D(II)=0.D0
      DO 10 II=1,NPARM
      F(II)=0.D0
10    COEF(II)=0.D0
      DO 100 NOB=1,NOBS
      WT=1.D0
      IF(SIG(NOB).NE.0.D0) WT=1.D0/SIG(NOB)
      IF(N.NE.0) CALL CALMTX(X(NOB),H2N,N,IPARM,ELAM,I,NDERVP,XARRAY,
     *NOB)
      IST(NOB)=I
      DO 110 ILOP=1,N
110   F(I+ILOP-1)=XARRAY(1,NOB,N-ILOP+1)*WT
      IF(T.NE.0) CALL CALTRG(T,TS,N,NOB,X(NOB),FREQ,XARRAY,NDERVP)
      IF((IPARM.EQ.0).AND.(T.NE.0)) XARRAY(1,NOB,NPARM)=1.D0
      DO 123 ILOP=1,JPARM
123   F(IPARM+ILOP)=XARRAY(1,NOB,N+ILOP)*WT
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      F(NPARM+1)=S(NOB)*WT
      CALL CALNOR(D,F,NPARM)
      DO 120 ILOP=1,N
  120 F(I+ILOP-1)=0.D0
      DO 121 ILOP=1,JPARM
  121 F(IPARM+ILOP)=0.D0
  100 F(NPARM+1)=0.D0
      DO 176 I=1,NPARM
      CSUM(I)=0.D0
      DO 176 J=1,NPARM
      NTOT=I+J
      NROW=MIN0(I,J)
      NCOL=NTOT-NROW
      K=INDX(NROW,NCOL,NPARM)
  176 CSUM(I)=CSUM(I)+D(K)
      IF(N.EQ.0) IUVEC=2
      CALL CALINV(NPARM,NOPP,D,DIAG,NP1,IUVEC,ISING)
      DO 880 I=1,NPARM
      DIAG(I)=0.D0
      DO 885 J=1,NPARM
      NTOT=I+J
      NROW=MIN0(I,J)
      NCOL=NTOT-NROW
      K=INDX(NROW,NCOL,NPARM)
      KRHS=INDX(J,NPARM+1,NPARM)
      COEF(I)=COEF(I)+D(KRHS)*D(K)
  885 DIAG(I)=DIAG(I)+D(K)*CSUM(J)
      IF((ISHOW.NE.1).AND.(ISHOW.NE.2)) GO TO 880
      IF((I.EQ.1).AND.(IPARM.NE.0)) WRITE(6,131)
  131 FORMAT(//1X,'B-SPLINE COEFFICIENTS .....'//5X,'I',16X,'COEF(I)',16
     *X,'DIAG(I)'//)
      IF(I.EQ.IPARM+1) WRITE(6,101)
  101 FORMAT(//1X,'FOURIER COEFFICIENTS .....'//5X,'I',16X,'COEF(I)',16X
     *,'DIAG(I)'//)
      IF(I.LE.IPARM) WRITE(6,990) I,COEF(I),DIAG(I)
      IF(I.GT.IPARM) WRITE(6,990) I-IPARM,COEF(I),DIAG(I)
  880 CONTINUE
  990 FORMAT(1X,I5,2(3X,F20.10))
      DO 890 NOB=1,NOBS
      CALL CALCOF(FCT,COEF,XARRAY,N,NDERVP,IST(NOB),NOB,NPARM,IPARM)
      DO 890 ID=1,NDERVP
  890 V(ID,NOB)=FCT(ID)
      CALL CALVAR(NOBS,IST,XARRAY,D,N,NPARM,G,ICOV,NDCVMP,ICOR,GSIG,
     *ISHOW,INTERP,JPARM)
      IF((ISHOW.EQ.1).OR.(ISHOW.EQ.2)) WRITE(6,951)
  951 FORMAT(//1X,'B-SPLINE FITS .....'//3X,'OBS',8X,'X VALUE',15X,'S0(X
     *)',9X,'RESIDUAL(X)',15X,'S1(X)',15X,'S2(X)',15X,'S3(X)...'//)
      RMEAN=0.D0
      RSS=0.D0
      DO 819 NOB=1,NOBS
      RESID(NOB)=S(NOB)-V(1,NOB)
      IF(NOB.EQ.1) RESMIN=RESID(NOB)
      IF(NOB.EQ.1) RESMAX=RESID(NOB)
      IF(RESID(NOB).LT.RESMIN) RESMIN=RESID(NOB)
      IF(RESID(NOB).GT.RESMAX) RESMAX=RESID(NOB)
      IF((ISHOW.EQ.1).OR.(ISHOW.EQ.2)) WRITE(6,995) NOB,X(NOB),V(1,NOB),
     *RESID(NOB),(V(ID,NOB),ID=2,NDERVP)
  995 FORMAT(1X,I5,F15.8,5F20.10)
      RMEAN=RMEAN+RESID(NOB)
      WT=1.D0
```

```
      IF(SIG(NOB).NE.0.D0) WT=1.D0/SIG(NOB)
819   RSS=RSS+(RESID(NOB)*WT)**2
      RESINC=(RESMAX-RESMIN)/REAL(INTV)
      RMEAN=RMEAN/NOBS
      WTRMS=DSQRT(RSS/NOBS)
      IF((ISHOW.EQ.1).OR.(ISHOW.EQ.2)) CALL CALSTA(WTRMS,RMEAN,RESID,
     *NOBS,RESMAX,RESMIN,RSTDV)
      IF(IPRINT.GT.0) CALL BSPLOT(IPRINT,X,S,V,GSIG,NOBS,NDCVMP,NDERVP,
     *ELAM,H,N,RESID,INTV,RESMIN,RESINC,RMEAN,RSTDV)
      RETURN
360   NOB=1
      IF(N.NE.0) CALL CALMTX(XINTRP,H2N,N,IPARM,ELAM,I,NDERVP,XARRAY,
     *NOB)
      IF(T.NE.0) CALL CALTRG(T,TS,N,NOB,XINTRP,FREQ,XARRAY,NDERVP)
      CALL CALCOF(FCT,COEF,XARRAY,N,NDERVP,I,NOB,NPARM,IPARM)
      IST(NOB)=I
      CALL CALVAR(NOB,IST,XARRAY,D,N,NPARM,G,ICOV,NDCVMP,ICOR,GSIG,
     *ISHOW,INTERP,JPARM)
      DO 893 ID=1,NDERVP
      V(ID,1)=FCT(ID)
      IF((ISHOW.EQ.0).OR.(ISHOW.EQ.2)) GO TO 893
      GVAR=GSIG(ID,1)**2
      IF(ID.LE.NDCVMP) WRITE(6,491) ID-1,V(ID,1),GSIG(ID,1),GVAR
491   FORMAT(1X,'S',I1,'(X) VALUE = ',F20.10,3X,'SIGMA = ',F20.10,3X,'VA
     *RIANCE = ',F20.10)
      IF(ID.GT.NDCVMP) WRITE(6,492) ID-1,V(ID,1)
492   FORMAT(1X,'S',I1,'(X) VALUE = ',F20.10)
893   CONTINUE
      RETURN
      END
      SUBROUTINE CALMTX(X,H2N,N,NPARM,ELAM,I,NDERVP,ARRAY,NOB)
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION ELAM(500),ARRAY(6,500,20),ARNNJJ(6)
      INTEGER H2N
      DATA ARNNJJ/6*0.D0/
      INDXX(NROW,NCOL,NDIM)=(NROW*(NDIM+NDIM+1-NROW))/2+NCOL-NDIM
      NPARM1=NPARM+1
      CALL BSERCH(N,NPARM1,ILAM,X,ELAM,I)
      DO 747 ID=1,NDERVP
747   ARRAY(ID,NOB,1)=0.D0
      DELT=ELAM(ILAM)-ELAM(ILAM-1)
      IF(DELT.NE.0.D0) ARRAY(1,NOB,1)=1.D0/DELT
      IF(N.EQ.1) GO TO 200
      KSHIFT=-1
      IILAM=ILAM
      DO 100 JJ=1,N
      KSHIFT=KSHIFT+1
      DO 150 NN=JJ,N
      IF(JJ.EQ.1.AND.NN.EQ.1) GO TO 150
      DEL=ELAM(IILAM)-ELAM(IILAM-NN)
      IF(NN.EQ.N) DEL=1.D0
      INDJM1=INDXX(JJ-KSHIFT,NN-KSHIFT,N)
      INDJEQ=INDXX(JJ-KSHIFT,NN-1-KSHIFT,N)
      DO 210 ID=1,NDERVP
      ARJM1=0.D0
      ARJEQ=0.D0
      IF(JJ.NE.1) ARJM1=ARRAY(ID,NOB,INDJM1)
      IF(NN.NE.JJ) ARJEQ=ARRAY(ID,NOB,INDJEQ)
      ARIJM1=0.D0
      ARIJEQ=0.D0
```

```
      IF(ID.EQ.1) GO TO 35
      IF(JJ.NE.1) ARIJM1=ARRAY(ID-1,NOB,INDJM1)
      IF(NN.NE.JJ) ARIJEQ=ARRAY(ID-1,NOB,INDJEQ)
 35   ARNNJJ(ID)=(X-ELAM(IILAM-NN))*ARJM1+(ELAM(IILAM)-X)*ARJEQ+(DFLOAT(
     *ID-1)*(ARIJM1-ARIJEQ))
210   IF(DABS(ARNNJJ(ID)).LE.1.D-25) ARNNJJ(ID)=0.D0
      DO 177 ID=1,NDERVP
      IF(JJ.EQ.1) ARRAY(ID,NOB,INDJEQ+1)=ARNNJJ(ID)/DEL
177   IF(JJ.NE.1) ARRAY(ID,NOB,INDJM1)=ARNNJJ(ID)/DEL
150   CONTINUE
100   IILAM=IILAM+1
200   RETURN
      END
      SUBROUTINE CALCOF(FCT,COEF,ARRAY,N,NDERVP,I,NOB,NPARM,IPARM)
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION FCT(1),COEF(1),ARRAY(6,500,20)
      DO 200 ID=1,NDERVP
200   FCT(ID)=0.D0
      DO 300 K=1,N
      DO 300 ID=1,NDERVP
300   FCT(ID)=FCT(ID)+COEF(I+K-1)*ARRAY(ID,NOB,N-K+1)
      JPARM=NPARM-IPARM
      IF(JPARM.EQ.0) RETURN
      DO 400 L=1,JPARM
      DO 400 ID=1,NDERVP
400   FCT(ID)=FCT(ID)+COEF(IPARM+L)*ARRAY(ID,NOB,N+L)
      RETURN
      END
      SUBROUTINE CALNOR(D,F,NPARM)
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION D(1),F(1)
      NOP=NPARM+1
      K=1
      DO 27 I=1,NPARM
      FWT=F(I)
      NLENG=NOP-I+1
      DO 28 J=1,NLENG
 28   D(K+J-1)=D(K+J-1)+FWT*F(I+J-1)
 27   K=K+NLENG+1
      RETURN
      END
      SUBROUTINE CALINV(LL,MM,A,R,NP1,IUVEC,ISING)
      DOUBLE PRECISION A(1),DPIV,DSUM,A2,R(1)
      IDIGL=0
      LTROW=1
      IF(LL.LT.1)GO TO 900
      LL1=LL-1
      K1=0
      LM=MM-LL
      IND=-LM
      DO 90 K=1,LL
      IND=IND+LM
      KPIV=IND+1
      LEND=K-1
      TOL=A(KPIV)
      DO 80 I=K,LL
      IND=IND+1
      DSUM=0.D0
      IF(LEND)30,30,10
 10   LANF=K
```

```
      LIND=I-K
      DO 20 L=1,LEND
      DSUM=DSUM+A(LANF)*A(LANF+LIND)
   20 LANF=LANF+MM-L
   30 DSUM=A(IND)-DSUM
      IF(I.NE.K)GO TO 70
      IF(DSUM)900,900,40
   40 IDIG=ALOG10(TOL/SNGL(DSUM))-.5
      IF(IDIG.LE.IDIGL)GO TO 60
      IDIGL=IDIG
      LTROW=I
   60 DPIV=DSQRT(DSUM)
      A1=(1.D0/DPIV)
      A2=(1.D0-DBLE(A1)*DPIV)/DPIV
      A(IND)=DPIV
      R(K)=DPIV
      GO TO 80
   70 A(IND)=A2*DSUM+DBLE(A1)*DSUM
   80 CONTINUE
   90 CONTINUE
      DO 152 K=1,LL
      DPIV=A(KPIV)
      A1=(1.D0/DPIV)
      A2=(1.D0-DBLE(A1)*DPIV)/DPIV
      A(KPIV)=A2+DBLE(A1)
      R(LL-K+1)=A(KPIV)
      LEND=K-1
      IF(LEND)130,130,110
  110 DO 120 L=1,LEND
      IND=KPIV+L
  120 A(IND)=-(A2*A(IND)+DBLE(A1)*A(IND))
  130 IF(K.EQ.LL)GO TO 152
      IND=KPIV
      KPIV=KPIV-LM-1-K
      LANF=IND
      DO 151 I=K,LL1
      LANF=LANF-LM-I
      DSUM=A(LANF)
      A(LANF)=A2*DSUM+DBLE(A1)*DSUM
      IF(LEND)151,151,140
  140 DO 150 L=1,LEND
      LIND=LANF+L
  150 A(LIND)=A(LIND)+DSUM*A(IND+L)
  151 CONTINUE
  152 CONTINUE
      DO 180 K=1,LL
      LIND=KPIV-1
      LANF=KPIV
      DO 170 I=K,LL
      DSUM=0.D0
      DO 160 L=KPIV,IND
      LIND=LIND+1
  160 DSUM=DSUM+A(L)*A(LIND)
      A(KPIV)=DSUM
      LIND=LIND+LM
  170 KPIV=KPIV+1
      KPIV=KPIV+LM
  180 IND=IND+MM-K
      ISING=0
      RETURN
```

```
 900 IF((IUVEC.EQ.NP1).OR.(IUVEC.EQ.LL)) GO TO 700
     IDIGL=-1
     LTROW=I
     WRITE(6,920) LTROW
 920 FORMAT(5X,'**** INVERSION FAILED AT ROW ',I3,' ****')
     STOP 13
 700 ISING=1
     RETURN
     END
     SUBROUTINE CALVAR(INUM,IST,ARRAY,D,N,NPARM,G,ICOV,NDCVMP,ICOR,
    *GSIG,ISHOW,INTERP,JPARM)
     IMPLICIT REAL*8(A-H,O-Z)
     DIMENSION G(13000),IST(1),ARRAY(6,500,20),D(1),GSIG(5,500)
     INDX(NROW,NCOL,NDIM)=(NROW*(NDIM+NDIM+5-NROW))/2+NCOL-NDIM-2
     INDXX(NROW,NCOL,NDIM)=(NROW*(NDIM+NDIM+1-NROW))/2+NCOL-NDIM
     MPARM=N+JPARM
     DO 10 L0=1,NDCVMP
     IF((INTERP.EQ.0).AND.(ISHOW.NE.0).AND.(ISHOW.NE.3)) WRITE(6,327)
    *L0-1
327  FORMAT(//1X,'S',I1,'(X)    COVARIANCE MATRIX ..... CORRELATION MAT
    *RIX .....'//4X,'I',3X,'J',10X,'COV(I,J)',10X,'SIGMAS',10X,'COR(I,J
    *)'//)
     KOUNT=0
     DO 11 L1=1,INUM
     IF(NPARM.NE.JPARM) ISTLM1=IST(L1)-1
     LIM=INUM
     IF(ICOV.EQ.0) LIM=L1
     DO 11 L2=L1,LIM
     IF(NPARM.NE.JPARM) ISTLM2=IST(L2)-1
     KOUNT=KOUNT+1
     G(KOUNT)=0.D0
     DO 11 JJ=1,MPARM
     IF(JJ.LE.N) JJPOS=ISTLM2+JJ
     IF(JJ.GT.N) JJPOS=NPARM-MPARM+JJ
     IF(JJ.LE.N) ARR2=ARRAY(L0,L2,N-JJ+1)
     IF(JJ.GT.N) ARR2=ARRAY(L0,L2,JJ)
     SUM=0.D0
     DO 12 II=1,MPARM
     IF(II.LE.N) IIPOS=ISTLM1+II
     IF(II.GT.N) IIPOS=NPARM-MPARM+II
     IF(II.LE.N) ARR1=ARRAY(L0,L1,N-II+1)
     IF(II.GT.N) ARR1=ARRAY(L0,L1,II)
     NTOT=IIPOS+JJPOS
     NROW=MIN0(IIPOS,JJPOS)
     NCOL=NTOT-NROW
     K=INDX(NROW,NCOL,NPARM)
12   SUM=SUM+ARR1*D(K)
11   G(KOUNT)=G(KOUNT)+ARR2*SUM
     KOWNT=0
     DO 13 IRS=1,INUM
     LIM=INUM
     IF(ICOV.EQ.0) LIM=IRS
     KI=INDXX(IRS,IRS,INUM)
     IF(ICOV.EQ.0) KI=IRS
     GIPIV=G(KI)
     DO 13 ICS=IRS,LIM
     KJ=INDXX(ICS,ICS,INUM)
     IF(ICOV.EQ.0) KJ=IRS
     GJPIV=G(KJ)
     KIJ=INDXX(IRS,ICS,INUM)
```

```
      IF(ICOV.EQ.0) KIJ=IRS
      GIJ=G(KIJ)
      IF(IRS.EQ.ICS) KOWNT=KOWNT+1
      IF(IRS.EQ.ICS) GSIG(L0,KOWNT)=DSQRT(GIJ)
      IF(INTERP.EQ.1) RETURN
      IF(ICOR.EQ.1) GCOR=GIJ/DSQRT(GIPIV*GJPIV)
      IF((ISHOW.EQ.0).OR.(ISHOW.EQ.3)) GO TO 13
      IF(ICOR.EQ.0) GO TO 27
      IF(IRS.EQ.ICS) WRITE(6,224) IRS,ICS,GIJ,GSIG(L0,KOWNT),GCOR
224   FORMAT(1X,2I4,3X,F15.8,5X,F11.8,3X,F15.8)
      IF(IRS.NE.ICS) WRITE(6,225) IRS,ICS,GIJ,GCOR
225   FORMAT(1X,2I4,3X,F15.8,19X,F15.8)
      GO TO 13
27    IF(IRS.EQ.ICS) WRITE(6,226) IRS,ICS,GIJ,GSIG(L0,KOWNT)
226   FORMAT(1X,2I4,3X,F15.8,5X,F11.8)
      IF(IRS.NE.ICS) WRITE(6,227) IRS,ICS,GIJ
227   FORMAT(1X,2I4,3X,F15.8)
13    CONTINUE
10    CONTINUE
      RETURN
      END
      SUBROUTINE BSERCH(N,NPARM1,ILAM,X,ELAM,I)
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION ELAM(1)
      IBEG=N
      IEND=NPARM1
30    MID=(IBEG+IEND)/2
      IF(IEND-IBEG.LE.1) GO TO 40
      IF(X.GE.ELAM(MID)) IBEG=MID
      IF(X.LT.ELAM(MID)) IEND=MID
      GO TO 30
40    ILAM=MID+1
      I=ILAM-N
      RETURN
      END
      SUBROUTINE BSPLOT(IFLAG,X,S,V,GSIG,NOBS,NDCVMP,NDERVP,ELAM,H,N,
     *RESID,INTV,RESMIN,RESINC,RMEAN,RSTDV)
      IMPLICIT REAL*4(A-H,O-Z)
      CHARACTER*1 SYMBOL(5)
      LOGICAL*1 IXFMT(7),IYFMT(7),DVNUM
      REAL*8 X(500),S(500),V(5,500),GSIG(5,500),ELAM(500),RESID(500)
      REAL*8 RESMIN,RESINC,RMEAN,RSTDV
      DIMENSION XS(500),SS(500),VS(500),GSIGS(500),ENOTX(100),ENOTY(100)
      DIMENSION RESIDS(500),EK(5,100),KK(5)
      INTEGER H
      EXTERNAL GAUSS
      DATA SYMBOL /'S','D','T','Q','V'/
      IF(IFLAG.EQ.1) CALL PLOTST(00001,1)
      IF(IFLAG.EQ.2) CALL PLOTST(02000,4)
      IF(IFLAG.EQ.3) CALL PLOTST(02001,4)
      IF(IFLAG.EQ.1) PHORX=66.0
      IF(IFLAG.EQ.1) PHORY=63.0
      IF(IFLAG.GT.1) PHORX=4.5
      IF(IFLAG.GT.1) PHORY=4.8
      DO 5 II=1,NOBS
      XS(II)=X(II)
5     SS(II)=S(II)
      CALL GRDNUM(XS,NOBS,XMIN,XMAX,LINT,IXFMT)
      CALL NOTPOS(IFLAG,N,H,XMAX,XMIN,ELAM,LTYPER,KK,EK)
      DO 10 II=1,NDERVP
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```
      DO 20 JJ=1,NOBS
20    VS(JJ)=V(II,JJ)
      IF(IFLAG.EQ.1) CALL SETGRD(11.0,10.0,123.0,60.0,1)
      IF(IFLAG.GT.1) CALL SETGRD(1.0,1.0,9.0,4.0,4)
      IF(II.EQ.1) GO TO 25
      CALL GRDNUM(VS,NOBS,PMIN,PMAX,MINT,IYFMT)
      GO TO 26
25    CALL MAXMIN(SS,NOBS,YMIN1,YMAX1)
      CALL MAXMIN(VS,NOBS,YMIN2,YMAX2)
      YMIN=YMIN1
      IF(YMIN2.LT.YMIN1) YMIN=YMIN2
      YMAX=YMAX1
      IF(YMAX2.GT.YMAX1) YMAX=YMAX2
      CALL PTYNUM(YMIN,YMAX,PMIN,PMAX,MINT)
      CALL FORMAT(PMIN,PMAX,IYFMT)
26    CALL OGRID(XMIN,XMAX,LINT,IXFMT,1,PMIN,PMAX,MINT,IYFMT,2,0)
      IF(II.EQ.1) CALL PLOT(XS,SS,NOBS,'X')
      CALL PLOT(XS,VS,NOBS,' ')
      DO 59 JL=1,LTYPER
      NKNT=KK(JL)
      DO 44 IK=1,NKNT
      ENOTX(IK)=EK(JL,IK)
44    ENOTY(IK)=PMIN
59    IF(KK(JL).GT.0) CALL PLOT(ENOTX,ENOTY,NKNT,SYMBOL(JL))
      IIM1=II-1
      CALL EDIT(IIM1,'I1)',DVNUM,NNUM,IBL)
      CALL HORLIN('B-SPLINE FIT: DERIVATIVE = ',27,PHORX,PHORY,0,0)
      CALL HORLIN(DVNUM,1,PHORX,PHORY,28,0)
10    CALL FRMADV
      DO 30 II=1,NDCVMP
      DO 40 JJ=1,NOBS
40    GSIGS(JJ)=GSIG(II,JJ)
      IF(IFLAG.EQ.1) CALL SETGRD(11.0,10.0,123.0,60.0,1)
      IF(IFLAG.GT.1) CALL SETGRD(1.0,1.0,9.0,4.0,4)
      CALL GRDNUM(GSIGS,NOBS,YMIN3,YMAX3,KINT,IYFMT)
      CALL OGRID(XMIN,XMAX,LINT,IXFMT,1,YMIN3,YMAX3,KINT,IYFMT,2,0)
      CALL PLOT(XS,GSIGS,NOBS,' ')
      DO 75 JL=1,LTYPER
      NKNT=KK(JL)
      DO 74 IK=1,NKNT
      ENOTX(IK)=EK(JL,IK)
74    ENOTY(IK)=YMIN3
75    IF(KK(JL).GT.0) CALL PLOT(ENOTX,ENOTY,NKNT,SYMBOL(JL))
      IIM1=II-1
      CALL EDIT(IIM1,'I1)',DVNUM,NNUM,IBL)
      CALL HORLIN('SIGMA PER OBSERVATION: DERIVATIVE = ',36,PHORX,PHORY,
     *0,0)
      CALL HORLIN(DVNUM,1,PHORX,PHORY,37,0)
30    CALL FRMADV
      DO 50 JJ=1,NOBS
50    RESIDS(JJ)=RESID(JJ)
      IF(IFLAG.EQ.1) CALL SETGRD(11.0,10.0,123.0,60.0,1)
      IF(IFLAG.GT.1) CALL SETGRD(1.0,1.0,9.0,4.0,4)
      CALL GRDNUM(RESIDS,NOBS,YMIN4,YMAX4,LINT,IYFMT)
      CALL OGRID(XMIN,XMAX,LINT,IXFMT,1,YMIN4,YMAX4,LINT,IYFMT,2,0)
      CALL PLOT(XS,RESIDS,NOBS,' ')
      DO 17 JL=1,LTYPER
      NKNT=KK(JL)
      DO 84 IK=1,NKNT
      ENOTX(IK)=EK(JL,IK)
```

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84    ENOTY(IK)=YMIN4
17    IF(KK(JL).GT.0) CALL PLOT(ENOTX,ENOTY,NKNT,SYMBOL(JL))
      CALL HORLIN('RESIDUAL PER OBSERVATION',24,PHORX,PHORY,0,0)
      CALL FRMADV
      INTVP1=INTV+1
      ELM=RESMIN
      DO 60 II=1,INTVP1
      XS(II)=ELM
      SS(II)=0.0
60    ELM=ELM+RESINC
      RMAX=0.D0
      DO 70 II=1,NOBS
      DO 70 JJ=1,INTV
      IF((RESIDS(II).GE.XS(JJ)).AND.(RESIDS(II).LE.XS(JJ+1))) SS(JJ+1)=
     *SS(JJ+1)+1.0
70    IF(SS(JJ+1).GT.RMAX) RMAX=SS(JJ+1)
      DO 80 II=1,INTV
      ENOTX(II)=(XS(II)+XS(II+1))/2.0
      ENOTY(II)=GAUSS(RMEAN,RSTDV,XS(II),XS(II+1),NOBS)
80    IF(ENOTY(II).GT.RMAX) RMAX=ENOTY(II)
      MRX=NINT(RMAX)
      IF(IFLAG.EQ.1) CALL SETGRD(11.0,10.0,123.0,60.0,1)
      IF(IFLAG.GT.1) CALL SETGRD(1.0,1.0,9.0,4.0,4)
      CALL OGRID(XS(1),XS(INTVP1),INTV,'F6.1 ',4,0.0,RMAX,MRX,'I4 ',2,0)
      CALL VERHST(XS,SS,INTVP1)
      CALL PLOT(ENOTX,ENOTY,INTV,'*')
      CALL HORLIN('RESIDUAL DISTRIBUTION (NORMAL=*)',32,PHORX,PHORY,0,0)
      CALL ENDPLT
      RETURN
      END
      SUBROUTINE NOTPOS(IFLAG,N,NH,XMAX,XMIN,ELAM,LTYPER,KK,EK)
      REAL*8 ELAM(500)
      DIMENSION EK(5,100),KK(5)
      DO 10 II=1,5
10    KK(II)=0
      LTYPER=1
      IF(IFLAG.EQ.1) TINC=(XMAX-XMIN)/112.0
      IF(IFLAG.GT.1) TINC=(XMAX-XMIN)/80.0
      II=0
20    II=II+1
      IF(II.GT.NH) GO TO 50
      SUMK=REAL(ELAM(II+N))
      JJ=0
30    JJ=JJ+1
      IF(II+JJ.GT.NH) GO TO 40
      IF(ABS(REAL(ELAM(II+N)-ELAM(II+N+JJ))).GT.TINC) GO TO 40
      SUMK=SUMK+REAL(ELAM(II+N+JJ))
      GO TO 30
40    KK(JJ)=KK(JJ)+1
      IF(LTYPER.LT.JJ) LTYPER=JJ
      EK(JJ,KK(JJ))=SUMK/REAL(JJ)
      II=II+JJ-1
      GO TO 20
50    RETURN
      END
      SUBROUTINE CALTRG(NTRIG,TS,N,NOB,XOB,FREQ,XARRAY,NDERVP)
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION FREQ(500),XARRAY(6,500,20)
      DATA TWOPI /6.283185307179579/
      OBS=XOB-TS
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      IPARTL=N
      DO 10 IFRQ=1,NTRIG
      OMEGA=TWOPI*FREQ(IFRQ)
      THETA=OMEGA*OBS
      DO 20 I=1,NDERVP
      IF(MOD(I,2).EQ.0) GO TO 30
      XARRAY(I,NOB,IPARTL+1)=OMEGA**(I-1)*COS(THETA)
      XARRAY(I,NOB,IPARTL+2)=OMEGA**(I-1)*SIN(THETA)
      GO TO 40
   30 XARRAY(I,NOB,IPARTL+1)=OMEGA**(I-1)*SIN(THETA)
      XARRAY(I,NOB,IPARTL+2)=OMEGA**(I-1)*COS(THETA)
   40 IREM=MOD(I,4)
      GO TO (20,50,60),IREM
      XARRAY(I,NOB,IPARTL+2)=-XARRAY(I,NOB,IPARTL+2)
      GO TO 20
   50 XARRAY(I,NOB,IPARTL+1)=-XARRAY(I,NOB,IPARTL+1)
      GO TO 20
   60 XARRAY(I,NOB,IPARTL+1)=-XARRAY(I,NOB,IPARTL+1)
      XARRAY(I,NOB,IPARTL+2)=-XARRAY(I,NOB,IPARTL+2)
   20 CONTINUE
   10 IPARTL=IPARTL+2
      RETURN
      END
      SUBROUTINE CALSTA(WTRMS,RMEAN,RESID,NOBS,RESMAX,RESMIN,RSTDV)
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION RESID(500)
      RSKEW=0.D0
      RKURT=0.D0
      DO 10 MEXP=2,4
      RMOM=0.D0
      DO 20 II=1,NOBS
   20 RMOM=RMOM+(RESID(II)-RMEAN)**MEXP
      IF(MEXP.NE.2) GO TO 30
      RSTDV=SQRT(RMOM/(NOBS-1))
      IF(RSTDV.EQ.0.D0) GO TO 50
   30 IF(MEXP.NE.3) GO TO 40
      RSKEW=RMOM/(RSTDV**3*NOBS)
   40 IF(MEXP.NE.4) GO TO 10
      RKURT=RMOM/(RSTDV**4*NOBS)
   10 CONTINUE
   50 WRITE(6,100) RESMAX,WTRMS,RSKEW,RMEAN,RSTDV,RKURT,RESMIN
  100 FORMAT(//1X,'RESIDUAL STATISTICS .....'//1X,'MAXIMUM = ',F20.10,10
     *X,'WEIGHTED RMS = ',F20.10,10X,'SKEWNESS = ',F20.10/1X,'AVERAGE =
     *',F20.10,10X,'STANDARD DEV = ',F20.10,10X,'KURTOSIS = ',F20.10/1X,
     *'MINIMUM = ',F20.10)
      RETURN
      END
      FUNCTION GAUSS(RMEAN,RSTDV,X1,X2,NOBS)
      IMPLICIT REAL*4 (A-H,O-Z)
      REAL*8 RMEAN,RSTDV
      X3=(X1-RMEAN)/RSTDV/SQRT(2.0)
      X4=(X2-RMEAN)/RSTDV/SQRT(2.0)
      GAUSS=REAL(NOBS)*0.5*(ERF(X4)-ERF(X3))
      RETURN
      END
```

PROGRAM BINSIFT: ....

```
//XRJRRSFT  JOB (F8002,X22,15),'BINSIFT',TIME=(1,0),CLASS=O,
//  MSGCLASS=X
//* JCL = XRJRR.DMSP.PROGRAMS(BINSIFT)
//STEP1 EXEC FORTRAN,FVPXREF=XREF
//SYSIN DD *

C======================================================================C
C   THIS PROGRAM TAKES DMSP DATA, SORTED INTO EQUAL AREA BINS,         C
C   AND WEEDS THE NUMBER OF POINTS IN THAT BIN DOWN TO A SPECIFIED     C
C   NUMBER OF POINTS.  A PREVIOUS DELETION OF POINTS WAS MADE ON AN    C
C   ORBIT-BY-ORBIT BASIS BY T.J. SABAKA'S DMSP PROCESSING PROGRAM.     C
C   DST VALUES HAVE BEEN ADDED TO THE DATA BY 'DSTADD', INTO SLOT #17. C
C   BIN NUMBERS ARE IN SLOT #16, AND THE 'INOTE' FLAG IN SLOT #18.     C
C   FOR THIS PROGRAM, AN INOTE=0 MEANS GOOD DATA, AND INOTE .NE. 0     C
C   MEANS BAD DATA.                                                    C
C                                                                      C
C   THIS PROGRAM CONTINUES THE REJECTION PROCESS.  IT FIRST REJECTS    C
C   POINTS ACCORDING TO DST(RANGE -20 TO +5) AND THEN RANDOMLY REJECTS C
C   POINTS IN A BIN UNTIL THE GOAL IS MET.                             C
C                                                                      C
C   THE GOAL IS 9 POINTS PER BIN FOR DIPOLE LATITUDE .GT. 30 DEGREES, C
C   AND 3 POINTS PER BIN FOR DIPLAT .LT. 30 DEGREES, FOR DMSP DATA ONLYC
C                                                                      C
C======================================================================C
C                                                                      C

      REAL*8 CENTER,BLKSIZ,CLAT,CLON,DIPLAT
      DIMENSION TEMP(28,500),ITEMP(28,500),RA(28),IA(28),OA(28),
     @ KTEMP(500),CENTER(500,2)
      EQUIVALENCE (TEMP(1,1),ITEMP(1,1))
      EQUIVALENCE (RA(1),IA(1))
      DATA BLKSIZ/10.0/,ISEED/123456/
C
C  CALL ZONE AND MIDDLE TO FIND CENTER OF EACH 10X10 BIN.
      CALL ZONE(BLKSIZ)
      CALL MIDDLE(CENTER)

C  INITIALIZE RANDOM NUMBER GENERATOR.
      CALL RANDU(ISEED,IY,YOUT)
C
C  COUNTER VARIABLES:
C            NBIN :  BIN #
C            IBIN :  # OF POINTS IN A BIN
C           IGOAL :  # OF POINTS IN BIN AFTER WEEDING PROCESS
C            IBAD :  # OF BAD POINTS PER BIN FROM PREVIOUS WEEDING.
C           IGOOD :  # OF GOOD POINTS PER BIN.  CHANGES W/ WEEDING.
C            IDST :  # OF POINTS PER BIN REJECTED BECAUSE OF DST.
C            IRAN :  RANDOM INTEGER BETWEEN 1 AND IGOOD
C            KZAP :  NUMBER OF POINTS REJECTED IN RANDOM POINT
C                    REJECTION OPTION.
C      ITEMP(18,I) : INOTE REJECTION FLAG.  INOTE=0 MEANS GOOD DATA.
C
```

```
      NBIN = 1
      IBIN = 0

    2 READ(10,END=6) RA
      IF(IA(1) .EQ. 0) GO TO 2

    3 IBLKNO = IA(16)
      IF(IBLKNO .NE. NBIN) GO TO 6
      IBIN = IBIN+1
      DO 4 J=1,28
    4 TEMP(J,IBIN) = RA(J)
      GO TO 2

    6 IF(IBIN .EQ. 0) THEN
        WRITE(6,600) NBIN
      NBIN = NBIN+1
C  FOR A BLKSIZE OF 10.0, THE MAXIMUM # OF BINS EQUALS 426
      IF(NBIN .GT. 426) GO TO 44
      GO TO 3
      ENDIF

      CLAT = CENTER(NBIN,1)
      CLON = CENTER(NBIN,2)
C
C  CALCULATE DIPOLE LATITUDE OF CENTER OF BIN NBIN.
      CALL DIPOLE(CLAT,CLON,DIPLAT)
      WRITE(6,611) NBIN,CLAT,CLON,DIPLAT
  611 FORMAT(/,8X,I3,' CLAT,CLON,DIPLAT: ',3(F7.2,2X))
C  SET IGOAL ACCORDING TO DIP LATITUDE.
      IF( DABS(DIPLAT) .LE. 30.0 ) THEN
        IGOAL = 3
      ELSE
        IGOAL = 9
      ENDIF

C  FIND IBAD, INITIAL IGOOD
      IBAD = 0
      IGOOD = 0
      DO 10 I=1,IBIN
        IF(ITEMP(18,I) .EQ. 0) THEN
          IGOOD = IGOOD+1
        ELSE
          IBAD = IBAD + 1
        ENDIF
   10 CONTINUE

      IF( IGOOD .LE. IGOAL ) THEN
        WRITE(6,601) NBIN,IBIN,IGOOD,IBAD,IGOAL
        GO TO 33
      ENDIF

C  ALL BINS WHICH GET TO THIS STAGE STILL HAVE TOO MANY GOOD POINTS.
      IDST = 0
      DO 15 I=1,IBIN
        IF(ITEMP(18,I) .NE. 0) GO TO 15
```

```
C       (NEXT IF BLOCK IS FOR GOOD POINTS ONLY)
        IF (IGOOD .GT. IGOAL) THEN
            IF( ITEMP(17,I) .LT. -20 .OR. ITEMP(17,I) .GT. 5 ) THEN
               ITEMP(18,I) = 7
               IGOOD = IGOOD-1
               IDST = IDST+1
               GO TO 15
            ENDIF
        ELSE
            WRITE(6,602) NBIN,IBIN,IGOOD,IBAD,IDST,IGOAL
            GO TO 33
        ENDIF

   15 CONTINUE

C  AT THIS POINT, BIN STILL HAS TOO MANY GOOD POINTS, EVEN AFTER IBAD,
C  DST REJECTIONS.
C  NOW RANDOMLY REJECT POINTS IN THE BIN UNTIL IGOAL HAS BEEN REACHED.

      K = 0
      DO 20 I=1,IBIN
        IF(ITEMP(18,I) .EQ. 0) THEN
          K = K+1
          KTEMP(K) = I
        ENDIF
   20 CONTINUE

      KZAP = 0
   21 IF (IGOOD .EQ. IGOAL) GO TO 25
C  GENERATE IRAN (BETWEEN 1 AND IGOOD)
      IX = IY
      CALL RANDU(IX,IY,ZOUT)
      IRAN = INT(ZOUT*IGOOD)
      IF(IRAN .EQ. 0) IRAN = 1

      KZAP = KZAP+1

C ADJUST KTEMP ACCORDING TO IRAN.
      IF( IRAN .EQ. IGOOD ) THEN
        IGOOD = IGOOD-1
        GO TO 21
      ELSE
        DO 23 K=IRAN,IGOOD-1
   23   KTEMP(K) = KTEMP(K+1)
        IGOOD = IGOOD-1
        GO TO 21
      ENDIF

C  FIRST SET ALL POINT FLAGS TO 'BAD', THEN SET POINTS IN KTEMP TO
C  GOOD.
   25 DO 27 I=1,IBIN
   27 ITEMP(18,I) = 7
      DO 28 I=1,IGOAL
        IQ = KTEMP(I)
   28   ITEMP(18,IQ) = 0
```

```
      WRITE(6,603) NBIN,IBIN,IGOOD,IBAD,IDST,KZAP,IGOAL

   33 DO 35 I=1,IBIN
        DO 34 J=1,28
   34   OA(J) = TEMP(J,I)
   35 WRITE(11) OA

      NBIN = NBIN+1
      IF(NBIN .GT. 426) GO TO 44
      IBIN = 0
      GO TO 3

   44 STOP

C===========    FORMATS    =============C
  600 FORMAT(/,2X,'*********** BIN NUMBER ',I3,' HAS ZERO POINTS')
  601 FORMAT(2X,'@@@@@@@@@ BIN # ',I3,' ALREADY AT IGOAL.',
     @ /,10X,'# POINTS IN BIN: ',I3,/,10X,
     @ '# GOOD POINTS IN BIN: ',I3,/,10X,'# BAD POINTS IN BIN: ',I3,
     @ /,15X,'IGOAL : ',I3)
  602 FORMAT(2X,'$$$$$$$$$ BIN # ',I3,' REDUCED TO IGOAL USING DST',
     @ 1X,'VALUES.',/,10X,'# POINTS IN BIN: ',I3,/,10X,
     @ '# GOOD POINTS IN BIN: ',I3,/,10X,'# BAD POINTS IN BIN: ',I3,
     @ /,10X,'# DST REJECTS IN BIN: ',I3,/,15X,'IGOAL : ',I3)
  603 FORMAT(2X,'ZZZZZZZZZ BIN # ',I3,' REDUCED TO IGOAL USING IRAN',
     @ 1X,'OPTION.',/,10X,'# POINTS IN BIN: ',I3,/,10X,
     @ '# GOOD POINTS IN BIN: ',I3,/,10X,'# BAD POINTS IN BIN: ',I3,
     @ /,10X,'# DST REJECTS IN BIN: ',I3,/,10X,'RANDOM REJECTS: ',I3,
     @ /,15X,'IGOAL : ',I3)
      END
C
C
      SUBROUTINE DIPOLE(DLAT,DLON,DIPLAT)

C  THIS ROUTINE CALCULATES THE DIPOLE LATITUDE OF A POSITION, GIVEN
C  ITS LAT AND LONG (DEGREES).  A GEOCENTRIC EARTH IS ASSUMED.

C  DRA CONVERST DEGREES TO RADIANS. THETA0 IS THE CO-LATITUDE OF
C  THE GEOMAGNETIC POLE, PHI0 THE LONGITUDE OF THE POLE (IN DEGREES).
      IMPLICIT REAL*8 (A-H,O-Z)
      DATA DRA/.0174532925208D0/,PHI0/289.2/
C
      THETA0 = 11.12*DRA
      TCOS0 = DCOS(THETA0)
      TSIN0 = DSIN(THETA0)
C
C  COMPUTE DIPLAT, ABSDIP
      COLAT = DRA*(90.0-DLAT)
      DELLON = DRA*(DLON-PHI0)
      Q = TCOS0*DCOS(COLAT) + TSIN0*DSIN(COLAT)*DCOS(DELLON)
      DIPLAT =  90.0 - (DACOS(Q))/DRA
C
      RETURN
      END
```

```
C
      SUBROUTINE ZONE(DELT)
      IMPLICIT REAL*8(A-H,O-Z)

      DIMENSION RLAT(180),RSQ(180),AREA(180)
      COMMON  J,N(180),M,T1,PHITOP(180),DLAM(180),NROW(180),PHIBAR(180)

C==============================================C
C       SPECIFY INITIAL DELT = DEL(ALAT) =     C
C       DEL(LAMBDA) = 10 DEGREES               C
C       DELT=10.D0                             C
C                                              C
C       SPECIFY POINT (ALAT,ALONG)             C
C       ALAT(-90,+90) ALONG(0,360)             C
C==============================================C

       DRCONV=3.14159265D0/180.D0


       J = (90.D0/DELT)
      NPOLBK = J * .25
       IF(NPOLBK.GT.3)NPOLBK=3
      DELL = 0
         DO 10 K=1,J
           DELL = DELL + DELT
   10     PHITOP(K) = DELL

          LAST=4
          DO 100 ITER=1,LAST
           PHIBAR(1) = PHITOP(1)/2.D0
           RLAT(1) = PHITOP(1)
        DO 20 K=2,J
          RLAT(K) = PHITOP(K) - PHITOP(K-1)
   20   PHIBAR(K) = (PHITOP(K) + PHITOP(K-1))/2.D0
       DO 30 K=1,J
   30      N(K) = 360.D0/DELT * DCOS(PHIBAR(K)*DRCONV)+.5
             DO 50 K=1,NPOLBK
              KJ = J+1-K
   50         N(KJ) = 4*(2*K-1)


       DO 60 K=1,J
           DLAM(K)=360.D0/N(K)
   60       RSQ(K)=DLAM(K)*DCOS(PHIBAR(K)*DRCONV)/RLAT(K)
C      DO 90 K=1,J
C   90 WRITE(6,120)K,N(K),PHITOP(K),PHIBAR(K),DLAM(K),RSQ(K),AREA(K)
C  120 FORMAT(1X,'K=',I3,2X,'N=',I3,2X,'PHITOP=',F5.2,
C     . 2X,'PHIBAR=',F5.2,2X,'DLAM=',F5.2,2X,'RSQ=',F5.3,2X,
C     . 'AREA(SQKM)=',F9.1)
       IF(ITER.EQ.LAST)GO TO 100
      DO 70 K=1,J
         CALL NEWTON(J,K,N,PHITOP(K))
   70   CONTINUE
  100 CONTINUE
       M=0
```

```
        DO 110 KK=1,J
  110     M=M+N(KK)

      RETURN
      END

C       SUBROUTINE NEWTON

      SUBROUTINE NEWTON(J,K,N,ALAT)
       IMPLICIT REAL *8(A-H,O-Z)
      DIMENSION N(180)
        DRCONV=3.14159265D0/180.D0

C   COMPUTE AREA FACTORS

      SUML=0.00
      SUMLL=0.00

      DO 10 L=1,K
   10     SUML=SUML+N(L)
      DO 20 LL=1,J
   20     SUMLL=SUMLL+N(LL)

      FACTOR=SUML/SUMLL
      ALAT=ALAT*DRCONV
      PHI0=ALAT


      DO 100 L=1,5
          DERIV=DCOS(PHI0)
          FP=(DSIN(PHI0)-FACTOR)/DERIV
          EPS=FP/PHI0


          IF(DABS(EPS).LT.1.D-5)GO TO 200
          ALAT=PHI0-FP
  100 PHI0=ALAT
  200 CONTINUE
       ALAT=ALAT/DRCONV
      RETURN
      END
C

      SUBROUTINE MIDDLE(CENTER)
                                                                            ==C
C=========================================================================== C
C     THIS SUBROUTINE CALCULATES THE LATITUDE AND LONGITUDE OF THE           C
C     CENTER OF EACH BIN.  THE COORDINATES  ARE THEN STORED IN THE           C
C     ARRAY 'CENTER.'                                                        C
C                                                                            C
C     FOR EXAMPLE, CENTER(4,1) AND CENTER(4,2) WOULD BE THE LATITUDE         C
C     AND LONGITUDE (RESPECTIVELY) OF THE CENTER OF THE FOURTH BIN.          C
C                                                                          ==C
C===========================================================================
```

```
      IMPLICIT REAL*8 (A-H,O-Z)
      REAL*4 RLAT,RLON,CSIZE
      CHARACTER*1 BIN(5)
      COMMON  J,N(180),M,T1,PHITOP(180),DLAM(180),NROW(180),PHIBAR(180)
      DIMENSION CENTER(500,2),NN(500)

C  NN  NUMBERS THE BINS CONSECUTIVELY.
C  (N IS THE NUMBER OF BINS IN EACH ROW.)

      NN(1) = 0
      DO 6 I = 2,J+1
  6     NN(I) = NN(I-1) + N(I-1)


CALCULATE CENTERS FOR NORTHERN HEMISPHERE

      DO 9 K = 2,J+1
      DO 8 I = NN(K-1)+1, NN(K)
        CENTER(I,1) = PHIBAR(K-1)
        IF(I.EQ.1) GO TO 7
        CENTER(I,2) = CENTER(I-1,2) + DLAM(K-1)
  7     CENTER(1,2) = DLAM(1)/2.D0
  8     IF(CENTER(I,2).GT.360.) CENTER(I,2) = DLAM(K-1)/2.D0
  9   CONTINUE


CALCULATE CENTERS FOR SOUTHERN HEMISPHERE

      DO 10 I = NN(J+1)+1, 2*NN(J+1)
        CENTER(I,1) = -CENTER(I-NN(J+1),1)
        CENTER(I,2) =  CENTER(I-NN(J+1),2)
 10   CONTINUE
      RETURN
      END

      SUBROUTINE RANDU(IX,IY,YFL)
C
C     ...............................................................
C
C        SUBROUTINE RANDU
C
C        PURPOSE
C           COMPUTES UNIFORMLY DISTRIBUTED RANDOM REAL NUMBERS BETWEEN
C           0 AND 1.0 AND RANDOM INTEGERS BETWEEN ZERO AND
C           2**31. EACH ENTRY USES AS INPUT AN INTEGER RANDOM NUMBER
C           AND PRODUCES A NEW INTEGER AND REAL RANDOM NUMBER.
C
C        USAGE
C           CALL RANDU(IX,IY,YFL)
C
C        DESCRIPTION OF PARAMETERS
C           IX - FOR THE FIRST ENTRY THIS MUST CONTAIN ANY ODD INTEGER
C                NUMBER WITH NINE OR LESS DIGITS. AFTER THE FIRST ENTRY,
C                IX SHOULD BE THE PREVIOUS VALUE OF IY COMPUTED BY THIS
C                SUBROUTINE.
```

```
C         IY - A RESULTANT INTEGER RANDOM NUMBER REQUIRED FOR THE NEXT
C              ENTRY TO THIS SUBROUTINE. THE RANGE OF THIS NUMBER IS
C              BETWEEN ZERO AND 2**31
C         YFL- THE RESULTANT UNIFORMLY DISTRIBUTED, FLOATING POINT,
C              RANDOM NUMBER IN THE RANGE 0 TO 1.0
C
C      REMARKS
C         THIS SUBROUTINE IS SPECIFIC TO SYSTEM/360 AND WILL PRODUCE
C         2**29 TERMS BEFORE REPEATING.  THE REFERENCE BELOW DISCUSSES
C         SEEDS (65539 HERE), RUN PROBLEMS, AND PROBLEMS CONCERNING
C         RANDOM DIGITS USING THIS GENERATION SCHEME.  MACLAREN AND
C         MARSAGLIA, JACM 12, P. 83-89, DISCUSS CONGRUENTIAL
C         GENERATION METHODS AND TESTS.  THE USE OF TWO GENERATORS OF
C         THE RANDU TYPE, ONE FILLING A TABLE AND ONE PICKING FROM THE
C         TABLE, IS OF BENEFIT IN SOME CASES.  65549 HAS BEEN
C         SUGGESTED AS A SEED WHICH HAS BETTER STATISTICAL PROPERTIES
C         FOR HIGH ORDER BITS OF THE GENERATED DEVIATE.
C         SEEDS SHOULD BE CHOSEN IN ACCORDANCE WITH THE DISCUSSION
C         GIVEN IN THE REFERENCE BELOW.  ALSO, IT SHOULD BE NOTED THAT
C         IF FLOATING POINT RANDOM NUMBERS ARE DESIRED,AS ARE
C         AVAILABLE FROM RANDU, THE RANDOM CHARACTERISTICS OF THE
C         FLOATING POINT DEVIATES ARE MODIFIED AND IN FACT THESE
C         DEVIATES HAVE HIGH PROBABILITY OF HAVING A TRAILING LOW
C         ORDER ZERO BIT IN THEIR FRACTIONAL PART.
C
C      SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C         NONE
C
C      METHOD
C         POWER RESIDUE METHOD DISCUSSED IN IBM MANUAL C20-8011,
C         RANDOM NUMBER GENERATION AND TESTING
C
C    ...................................................................
C
      IY=IX*65539
      IF(IY)5,6,6
    5 IY=IY+2147483647+1
    6 YFL=IY
      YFL=YFL*.4656613E-9
      RETURN
      END
// EXEC LINKGO,REGION.GO=500K
//GO.FT10F001 DD DSN=XRJRR.NOV2385.DST1,DISP=SHR
//GO.FT11F001 DD DSN=XRJRR.NOV2385.SIFT.DATA,
//  UNIT=SYSDA,SPACE=(TRK,(10,5),RLSE),VOL=SER=SACC05,
//  DISP=(NEW,CATLG),DCB=(RECFM=VBS,LRECL=116,BLKSIZE=11604)
// EXEC NOTIFYTS
11 9 0 0 0 01984.06371.2 0
```

COEFFICIENTS CAL84FID

XRDSC.DMSP.CALBB.TEST4.TEST.DATA

2	1	-29878.1992	0.0000	26.9879	0.0000	0.0000	0.0000
2	2	-1924.0500	5526.5508	7.9558	-19.3154	0.0000	0.0000
3	1	-2063.3401	0.0000	-16.6929	0.0000	0.0000	0.0000
3	2	3044.3201	-2183.8701	4.2478	-13.6396	0.0000	0.0000
3	3	1682.8701	-291.6460	5.0440	-22.9796	0.0000	0.0000
4	1	1279.3401	0.0000	-0.5587	0.0000	0.0000	0.0000
4	2	-2200.8101	-317.4509	-5.0723	4.5528	0.0000	0.0000
4	3	1250.1299	282.9050	-0.1853	3.0011	0.0000	0.0000
4	4	831.3350	-289.1660	-0.3731	-9.2377	0.0000	0.0000
5	1	943.0530	0.0000	1.3461	0.0000	0.0000	0.0000
5	2	776.3311	230.8580	-1.4823	4.6653	0.0000	0.0000
5	3	370.7820	-248.3420	-6.7795	2.0878	0.0000	0.0000
5	4	-424.3979	64.1152	-1.3651	2.8099	0.0000	0.0000
5	5	174.5670	-294.2991	-6.0780	0.7172	0.0000	0.0000
6	1	-211.9340	0.0000	1.4847	0.0000	0.0000	0.0000
6	2	358.8789	45.6865	0.4091	-0.1262	0.0000	0.0000
6	3	252.2410	145.8200	-2.2093	-0.9964	0.0000	0.0000
6	4	-90.4987	-152.3840	-4.0607	-0.4410	0.0000	0.0000
6	5	-162.3880	-77.5140	-0.1193	0.0529	0.0000	0.0000
6	6	-48.5517	97.0991	-0.1276	1.2475	0.0000	0.0000
7	1	50.2750	0.0000	0.5828	0.0000	0.0000	0.0000
7	2	65.8066	-14.4218	0.0736	0.0835	0.0000	0.0000
7	3	48.4155	88.5492	1.6242	-1.1229	0.0000	0.0000
7	4	-186.4770	71.0999	1.4083	0.1306	0.0000	0.0000
7	5	1.9858	-47.6321	-0.4003	-1.1404	0.0000	0.0000
7	6	15.7450	-2.9277	0.4817	-0.1775	0.0000	0.0000
7	7	-103.6940	20.6672	1.0083	0.8616	0.0000	0.0000
8	1	75.1637	0.0000	0.8018	0.0000	0.0000	0.0000
8	2	-62.4921	-83.4985	-0.8234	-0.2392	0.0000	0.0000
8	3	2.8062	-24.7745	0.3449	0.6610	0.0000	0.0000
8	4	23.7248	-4.3465	0.7469	0.2003	0.0000	0.0000
8	5	-4.9795	20.8105	1.8643	1.1319	0.0000	0.0000
8	6	1.1965	21.6843	0.1407	0.9747	0.0000	0.0000
8	7	10.5049	-23.1920	-0.0207	-0.0463	0.0000	0.0000
8	8	-2.1680	-5.2178	-0.1217	1.1180	0.0000	0.0000
9	1	20.3340	0.0000	0.4621	0.0000	0.0000	0.0000
9	2	5.2416	6.0690	-0.3242	-0.1839	0.0000	0.0000
9	3	1.0119	-18.4504	0.3637	-0.2367	0.0000	0.0000
9	4	-9.5814	6.2423	0.3523	0.5092	0.0000	0.0000
9	5	-10.2597	-23.2842	-0.8320	-0.2703	0.0000	0.0000
9	6	3.3773	6.9580	-0.2127	-0.5421	0.0000	0.0000
9	7	3.8130	14.4615	0.2749	-0.4055	0.0000	0.0000
9	8	4.6053	-15.2854	-0.3537	-0.5202	0.0000	0.0000
9	9	-2.7086	-11.8510	-0.3326	0.6775	0.0000	0.0000
10	1	5.4469	0.0000	0.0000	0.0000	0.0000	0.0000
10	2	10.3427	-20.8446	0.0000	0.0000	0.0000	0.0000
10	3	1.5372	15.3630	0.0000	0.0000	0.0000	0.0000
10	4	-12.3475	8.9692	0.0000	0.0000	0.0000	0.0000
10	5	9.4340	-5.3201	0.0000	0.0000	0.0000	0.0000
10	6	-3.4223	-6.3449	0.0000	0.0000	0.0000	0.0000
10	7	-1.1907	8.9932	0.0000	0.0000	0.0000	0.0000
10	8	6.6870	9.6466	0.0000	0.0000	0.0000	0.0000

10	9	1.5169	-5.9544	0.0000	0.0000	0.0000	0.0000
10	10	-5.0012	1.9564	0.0000	0.0000	0.0000	0.0000
11	1	-3.4339	0.0000	0.0000	0.0000	0.0000	0.0000
11	2	-3.9929	1.2819	0.0000	0.0000	0.0000	0.0000
11	3	2.2212	0.4725	0.0000	0.0000	0.0000	0.0000
11	4	-5.4240	2.6617	0.0000	0.0000	0.0000	0.0000
11	5	-1.9861	5.7697	0.0000	0.0000	0.0000	0.0000
11	6	4.5759	-4.2347	0.0000	0.0000	0.0000	0.0000
11	7	3.1589	-0.4227	0.0000	0.0000	0.0000	0.0000
11	8	0.9086	-1.3564	0.0000	0.0000	0.0000	0.0000
11	9	1.9800	3.5678	0.0000	0.0000	0.0000	0.0000
11	10	2.7993	-0.4621	0.0000	0.0000	0.0000	0.0000
11	11	-0.2744	-6.1346	0.0000	0.0000	0.0000	0.0000
0	0						
0	0						

PROGRAM DSTADD ....

```
//XRJRRDST JOB (F8002,X22,20),DSTADD,TIME=(2,00),CLASS=0,NOTIFY=XRJRR,
//   MSGCLASS=X
/*JOBPARM LINES=30
//*  PROGRAM TO ADD DST VALUES TO DMSP DATA.  ALSO ADDS BIN NUMBERS.
//*  XRJRR.DMSP.PROGRAMS(DSTADD)
// EXEC FORTRAN,PARM='XREF'
//SYSIN DD *

      DIMENSION A(28,100),IA(28,100),AA(28,5000),IAA(28,5000),
     @ IDST(24),IDEL(13),AOUT(28)
      EQUIVALENCE(A,IA)
      EQUIVALENCE(AA,IAA)

C  THIS PROGRAM READS IN DMSP DATA, IN "FIT" FORMAT, AS OUTPUT FROM
C T.J. SABAKA'S DMSP PROCESSING PROGRAM.  IT ADDS DST VALUES TO THE
C DATA, AND ALSO ADDS BIN NUMBERS TO THE DATA. IT ALSO DELETES
C SPECIFIED DATES AND HOURS FROM THE DATA, WHICH HAVE BEEN CHECKED TO
C HAVE HIGH KP INDICES OR EXCEPTIONALLY LARGE DST INDICES.
C FINALLY, THE PROGRAM SORTS THE DATA BY BIN NUMBER.
C
C  ***NOTE:  DATA IS INPUT IN A FORMAT WHICH HAS 100 DATA VALUES PER
C            LOGICAL RECORD.  IT IS OUTPUT ONE VALUE PER LREC.
C            DATA WILL EVENTUALLY BE OUTPUT 100 POINTS PER RECORD,
C            WITH A LATER PROGRAM.
C  **NOTE#2: THIS VERSION OF THE PROGRAM SORTS THE DATA WITH THE
C            "NEW" METHOD, POSSIBLY INEFFICIENT.

CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C  SET BLKSIZE.  ALSO SET THE DAYS AND HOURS OF DATA TO DELETE.
C  FORMAT OF DAYS AND HOURS IS (IFIX((IHR-1)/3) + 1)*1000 + DAY.
C  THIS COMBINES THE DAY AND THE HOUR "TRIPLET" INTO ONE NUMBER, TO
C  BE COMPARED TO THE ACTUAL TIME.  ALSO SET NUMBER OF HOURLY TRIPLETS
C  WHICH WILL BE DELETED (=NDEL).
      DATA BLKSIZ/10.0/
      DATA NDEL/1/,IDEL/5329,0000,0000,0000,0000,0000,0000,0000,
     @                   0000,0000,0000,0000,0000/
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC

      DRCONV = 3.14159265/180.0
C  READ INITIAL LINE OF DATA FROM DST TAPE.
      READ(9,101) IYR,IDAY,IDST
  101 FORMAT(2X,I2,I3,2X,24I4)

C  READ LINE OF DATA FROM TAPE 10.
C  KCOUNT COUNTS FROM 1 TO THE ENTIRE DATA SET.
C  NWRITE COUNTS THE NUMBER OF RECORDS WRITTEN OUT.
C  I COUNTS FROM 1 TO 100
C  KP COUNTS THE NUMBER OF RECORDS DELETED BECAUSE OF KP INDEX.

C  CALL ZONE TO SET UP EQUAL AREA BLOCKS OF (BLKSIZ) SIZE.
      CALL ZONE(BLKSIZ)
      KCOUNT = 0
      NWRITE = 0
```

```
      KP = 0
    2 READ(10,END=55) A
      KCOUNT = KCOUNT + 1
      I = 1
C  ACCEPT DATA ONLY WHICH DO NOT HAVE NEGATIVE DATA QUALITY FLAGS.
    4 IF(IA(18,I) .NE. 0 ) THEN
        I = I+1
        IF( I .GT. 100 ) GO TO 2
        GO TO 4
      ENDIF
      IF(IA(1,I) .EQ. 0) THEN
        I = I+1
        IF( I .GT. 100 ) GO TO 2
        GO TO 4
      ENDIF

      JYR = IFIX(A(5,I))
      JDAY = IA(1,I)
      STIME = FLOAT(IA(2,I))/3.60E6
      JHR = INT(STIME) + 1
C  DELETE DATA WHICH HAVE BAD KP OR DST INDICES(GIVEN IN DATA STMT).
      JTEST = ( (JHR-1)/3 + 1 )*1000 + JDAY
      IF( NDEL .EQ. 0 ) GO TO 7
      DO 5 J=1,NDEL
        IF(JTEST .EQ. IDEL(J)) THEN
          I = I+1
          KP = KP+1
          IF(I .GT. 100) GO TO 2
          GO TO 4
        ENDIF
    5 CONTINUE

C  TEST WHETHER JYR EQUALS IYR
    7 IF(JYR .EQ. IYR) THEN
          GO TO 9
      ENDIF
C  JYR DOESN'T EQUAL IYR, SO READ ANOTHER LINE OF DST TAPE
    8 READ(9,101) IYR,IDAY,IDST
      GO TO 7
C
    9 CONTINUE
C  NOW THAT JYR EQUALS IYR, TEST WHETHER JDAY EQUALS IDAY
   10 IF(JDAY .EQ. IDAY) THEN
          GO TO 14
      ENDIF
C  JDAY DOESN'T EQUAL IDAY, SO READ ANOTHER LINE OF DST TAPE.
   12 READ(9,101) IYR,IDAY,IDST
      GO TO 10

   14 CONTINUE
C  NOW JYR AND JDAY ARE CORRECT.  PULL OFF THE CORRECT HOURLY DST.
      JDST = IDST(JHR)
      NWRITE=NWRITE+1

C  NOW FIND THE CORRECT BIN NUMBER FOR THE DATA.
```

```
C  CALL INDX TO DETERMINE BLOCK NUMBER
      DLAT = A(6,I)
      DLON = A(7,I)
      CALL INDX(DLAT,DLON,IBLKNO)
C     WRITE(6,607) IBLKNO,NWRITE,IA(1,I),IA(2,I),DLAT,DLON
C 607 FORMAT(3X,'***',2X,I5,2X,I5,2X,I3,2X,I9,5X,2(F8.1,1X))
      IA(16,I)=IBLKNO
      IA(17,I)=JDST
C
C  PUT INFORMATION INTO OUTPUT ARRAY.
C  PUT BIN # INTO SLOT 16, DST VALUE INTO SLOT 17.
C  DO THIS THE "NEW" WAY, IN WHICH IT WILL BE PRE-SORTED BY BIN
C  NUMBER AS IT IS BEING PUT INTO THE ARRAY.
      IF(NWRITE .EQ. 1) THEN
        DO 17 JJ=1,28
   17   AA(JJ,1) = A(JJ,I)
        I = I+1
        IF( I .GT. 100 ) GO TO 2
        GO TO 4
      ENDIF

      K = 1
   20 KBLKNO = IAA(16,K)
      IF(KBLKNO .LE. IBLKNO) THEN
       K = K+1
       IF(K .GT. NWRITE) GO TO 25
       GO TO 20
      ENDIF

      DO 22 J=NWRITE,K,-1
      DO 22 JJ=1,28
   22 AA(JJ,J+1) = AA(JJ,J)
      DO 24 JJ=1,28
   24 AA(JJ,K) = A(JJ,I)
      GO TO 27

   25 DO 26 JJ=1,28
   26 AA(JJ,K)=A(JJ,I)

   27 CONTINUE
      I = I+1
      IF( I .GT. 100 ) GO TO 2
      GO TO 4
C
C  IF THE PROGRAM REACHES THIS NEXT LINE, THEN ALL DATA POINTS HAVE BEEN
C READ IN AND SORTED.  NOW WRITE OUT THE DATA.

   55 WRITE(6,605) NWRITE,KCOUNT,KP

      DO 58 J=1,NWRITE
      DO 57 JJ=1,28
   57 AOUT(JJ) = AA(JJ,J)
   58 WRITE(11) AOUT

C ******* FORMATS ******** C
```

```
  605 FORMAT(///,5X,'TOTAL RECORDS WRITTEN OUT: ',I5,/,5X,
     @ 'FINAL KCOUNT = ',I6,/,5X,'NUMBER OF KP DELETIONS: ',I5)
  606 FORMAT(2X,I5,2X,I5,5X,2(I3,2X))

      STOP
      END
C
C
      SUBROUTINE ZONE(DELT)
      IMPLICIT REAL *8(A-H,O-Z)
      DIMENSION N(180),PHIBAR(180),PHITOP(180),DLAM(180),RLAT(180),
     *RSQ(180),AREA(180)
      COMMON /ZONE1/ J,N,M,PHITOP,DLAM
      DRCONV=3.14159265D0/180.D0
      J=(90.D0/DELT)
      NPOLBK=J*0.25
      IF(NPOLBK.GT.3) NPOLBK=3
      DELL=0
      DO 10 K=1,J
      DELL=DELL+DELT
   10 PHITOP(K)=DELL
      LAST=4
      DO 100 ITER=1,LAST
      PHIBAR(1)=PHITOP(1)/2.D0
      RLAT(1)=PHITOP(1)
      DO 20 K=2,J
      RLAT(K)=PHITOP(K)-PHITOP(K-1)
   20 PHIBAR(K)=(PHITOP(K)+PHITOP(K-1))/2.D0
      DO 30 K=1,J
   30 N(K)=360.D0/DELT*DCOS(PHIBAR(K)*DRCONV)+0.5
      DO 50 K=1,NPOLBK
      KJ=J+1-K
   50 N(KJ)=4*(2*K-1)
      DO 60 K=1,J
      DLAM(K)=360.D0/N(K)
   60 RSQ(K)=DLAM(K)*DCOS(PHIBAR(K)*DRCONV)/RLAT(K)
      IF(ITER.EQ.LAST) GO TO 100
      DO 70 K=1,J
      CALL NEWTON(J,K,N,PHITOP(K))
   70 CONTINUE
  100 CONTINUE
      M=0
      DO 110 KK=1,J
  110 M=M+N(KK)
      RETURN
      END
      SUBROUTINE NEWTON(J,K,N,ALAT)
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION N(180)
      DRCONV=3.14159265D0/180.D0
      SUML=0.00
      SUMLL=0.00
      DO 10 L=1,K
   10 SUML=SUML+N(L)
      DO 20 LL=1,J
```

```
   20 SUMLL=SUMLL+N(LL)
      FACTOR=SUML/SUMLL
      ALAT=ALAT*DRCONV
      PHI0=ALAT
      DO 100 L=1,5
      DERIV=DCOS(PHI0)
      FP=(DSIN(PHI0)-FACTOR)/DERIV
      EPS=FP/PHI0
      IF(DABS(EPS).LT.1.0D-5)GO TO 200
      ALAT=PHI0-FP
  100 PHI0=ALAT
  200 CONTINUE
      ALAT=ALAT/DRCONV
      RETURN
      END
      SUBROUTINE INDX(ALAT,ALONG,IBLKNO)
      IMPLICIT REAL *8(A-H,O-Z)
      DIMENSION N(180),PHITOP(180),DLAM(180)
      COMMON /ZONE1/ J,N,M,PHITOP,DLAM
      IF(ALONG .LT. 0.D0) ALONG = ALONG + 360.D0
      APHI=DABS(ALAT)
      DO 10 IS=1,J
      I=IS
      IF(PHITOP(IS).GE.APHI) GO TO 300
   10 CONTINUE
  300 NTOT=0
      L=(ALONG/DLAM(I))+1
      IF(I.EQ.1) GO TO 30
      DO 20 JJ=2,I
      NTOT=NTOT+N(JJ-1)
   20 CONTINUE
   30 CONTINUE
      IBLKNO=NTOT+L
      IF(ALAT.LT.0) IBLKNO=IBLKNO+M
      RETURN
      END

C
// EXEC LINKGO,REGION.GO=3000K
//GO.FT09F001 DD DSN=XRJRR.DST81,DISP=SHR
//GO.FT10F001 DD DSN=XRSHS.NOV2385.STEP5.OUTBIN,DISP=SHR
//*  WRITE OUT TO TAPE 11
//GO.FT11F001 DD DSN=XRJRR.NOV2385.DST1,UNIT=SYSDA,
//  DCB=(RECFM=VBS,LRECL=116,BLKSIZE=11604),SPACE=(TRK,(10,5),RLSE),
//  VOL=SER=SACC03,DISP=(NEW,CATLG)
// EXEC NOTIFYTS
```

PROGRAM EUTRANS ....

```
//XRJRREUT JOB (F8002,X22,25),EUTRANS,TIME=(5,0),CLASS=E,NOTIFY=XRJRR,
//   MSGCLASS=X
//*  INPUT: DMSP DATA IN FIT FORMAT, SPACECRAFT COORDINATES (UNIT 10)
//*  INPUT#2: 3 EULAR ANGLES, 3 BIASES (DATA STATEMENT).
//*  OUTPUT: DMSP DATA TRANSFORMED AND CORRECTED (UNIT11).
/*JOBPARM LINES=10
// EXEC FORTRAN,PARM='XREF'
//SYSIN DD *
      DIMENSION A(28,100)
      DIMENSION AA(28)
      REAL*8 EU1,EU2,EU3,DRCONV,SL1,SL2,SL3
C
C  SET EULER ANGLES, BIASES, SLOPES FOR CORRECTIONS.
      DATA EU1/0.00119751D0/,EU2/-0.002591042D0/,EU3/-0.0032734508D0/
      DATA BS1/4.797/,BS2/-.5051/,BS3/0.6497/
      DATA SL1/0.99993646D0/,SL2/0.99960327D0/,SL3/1.0011901D0/
C
      DRCONV = 3.14159265/180.0
C
C  CALL ROUTINE TO CALCULATE TSM (EULER TRANSFORMATION) MATRIX FROM
C  INPUT EULER ANGLES EU1,EU2,EU3.   THE OUTPUT ELEMENTS OF THIS
C  MATRIX ARE STORED IN COMMON FOR USE IN SUBROUTINE APPLY.
C
      CALL EULER(EU1,EU2,EU3)
C
C  READ DATA FROM UNIT#10.
    1 READ(10,END=22) A
      I=1
C
C  PULL OFF A VALUE FROM A, PUT INTO AA FOR PROCESSING.
    2 DO 4 J=1,28
    4 AA(J) = A(J,I)

C     WRITE(6,611) AA(11),AA(12),AA(13)
C 611 FORMAT(2X,'BEFORE APPLY: ',3(F15.5,2X))

      IF( AA(11) .EQ. 0.0 ) GO TO 6
C  APPLY SLOPES, BIASES AND EULER ANGLE CORRECTIONS TO AA.
      CALL APPLY(AA,BS1,BS2,BS3,SL1,SL2,SL3)

C     WRITE(6,612) AA(11),AA(12),AA(13)
C 612 FORMAT(2X,'AFTER APPLY: ',3(F15.5,2X),/)

C  PUT AA BACK INTO A
    6 DO 8 J=11,13
    8 A(J,I) = AA(J)

C  WRITE OUT A IF NECESSARY.
      IF(I .EQ. 100) THEN
        WRITE(11) A
        NWRITE=NWRITE+1
        GO TO 1
      ENDIF
```

```
C  INCREMENT I, GO TO 2
      I = I+1
      GO TO 2
C
   22 WRITE(6,601) NWRITE
  601 FORMAT(//,5X,'A TOTAL OF ',I4,' RECORDS READ IN, WRITTEN OUT')
      STOP
      END
C************************************************************
MATM   1
C
      SUBROUTINE APPLY(A,BSX,BSY,BSZ,SLX,SLY,SLZ)
C
C  THIS ROUTINE APPLIES THE EULER ROTATION MATRIX CALCULATED IN
C  ROUTINE 'EULER' TO DATA IN ARRAY A.  FOR THIS VERSION OF APPLY,
C  A IS ASSUMED TO ALREADY BE IN SPACECRAFT COORDINATES.
C    A IS CORRECTED WITH BIASES AND SLOPES, THEN
C  CORRECTED FOR EULAR ANGLES BY TRANSFORMING WITH
C  ROTATION MATRIX TSM (IN COMMON BLOCK).
C
C  INPUT: A, X,Y, AND Z BIASES, X,Y,Z SLOPES, TSM MATRIX.
C  OUTPUT: A (CORRECTED)
C
      REAL*8 TSM11,TSM12,TSM13,TSM21,TSM22,TSM23,TSM31,TSM32,TSM33,
     @       SLX,SLY,SLZ
      DIMENSION A(28)
      COMMON /TSM/ TSM11,TSM12,TSM13,TSM21,TSM22,TSM23,TSM31,TSM32,
     @ TSM33
C
      B1X = A(11)
      B1Y = A(12)
      B1Z = A(13)
C
C  APPLY SLOPES AND BIASES.
      B2X = (1.0/SLX)*( B1X - BSX )
      B2Y = (1.0/SLY)*( B1Y - BSY )
      B2Z = (1.0/SLZ)*( B1Z - BSZ )
C
C  APPLY EULER ANGLE ROTATIONS TO B2X,B2Y,B2Z TO GET CORRECTED A.
      A(11) = TSM11*B2X + TSM12*B2Y + TSM13*B2Z
      A(12) = TSM21*B2X + TSM22*B2Y + TSM23*B2Z
      A(13) = TSM31*B2X + TSM32*B2Y + TSM33*B2Z
C
C
      RETURN
      END
C
C
      SUBROUTINE EULER(EU1,EU2,EU3)
C
C  THIS ROUTINE CALCUALATES THE NINE ELEMENTS OF TRANSFORMATION
C  MATRIX TSM, GIVEN EULER ANGLES EU1,EU2,EU3.  OUTPUT IS STORED
C  IN COMMON.
      REAL*8 EU1,EU2,EU3,TCOS1,TCOS2,TCOS3,TSIN1,TSIN2,TSIN3,
     @ TSM11,TSM12,TSM13,TSM21,TSM22,TSM23,TSM31,TSM32,TSM33
```

```
      REAL*8 PI,DRA
C
      COMMON/TSM/ TSM11,TSM12,TSM13,TSM21,TSM22,TSM23,TSM31,TSM32,
     @ TSM33
C
      DATA PI/3.14159265/
      DRA = PI/180.0
C
C  CONVERT DEGREES TO RADIANS.
      EU1 = EU1*DRA
      EU2 = EU2*DRA
      EU3 = EU3*DRA
      TCOS1 = DCOS(EU1)
      TCOS2 = DCOS(EU2)
      TCOS3 = DCOS(EU3)
      TSIN1 = DSIN(EU1)
      TSIN2 = DSIN(EU2)
      TSIN3 = DSIN(EU3)
C
      TSM11 = TCOS1*TCOS3
      TSM12 = TCOS1*TSIN3*TCOS2 + TSIN1*TSIN2
      TSM13 = (-1.0)*TCOS1*TSIN3*TSIN2 + TSIN1*TCOS2
      TSM21 = (-1.0)*TSIN3
      TSM22 = TCOS3*TCOS2
      TSM23 = (-1.0)*TCOS3*TSIN2
      TSM31 = (-1.0)*TSIN1*TCOS3
      TSM32 = (-1.0)*TSIN1*TSIN3*TCOS2 + TCOS1*TSIN2
      TSM33 = TSIN1*TSIN2*TSIN3 + TCOS1*TCOS2
C
      RETURN
      END
C
// EXEC LINKGO,REGION.GO=500K
//GO.FT10F001 DD DSN=XRJRR.DMSP.FITPRP,DISP=SHR
//*  TAPE 11 IS OUTPUT
//GO.FT11F001 DD DSN=XRJRR.GARP,UNIT=SYSDA,DISP=(NEW,CATLG),
00006000
//  DCB=(RECFM=VBS,LRECL=11204,BLKSIZE=22412),SPACE=(TRK,(20,20),RLSE),
00006100
//  VOL=SER=SACC07
// EXEC NOTIFYTS
```

PROGRAM FITPREP ....

```
//XRJRRPRP JOB (F8002,X22,30),FITPRP,TIME=(0,30),CLASS=0,NOTIFY=XRJRR,
//   MSGCLASS=X
/*JOBPARM LINES=10
// EXEC FORTRAN,PARM='XREF'
//SYSIN DD *
      DIMENSION A(28),IA(28)
      DIMENSION AA(28,100)
      EQUIVALENCE(A,IA)
C====================================================================C
C  THIS PROGRAM READS IN DMSP DATA, WHICH HAS BEEN FLAGGED
C  AND SIFTED BY PROGRAMS DSTADD AND BINSIFT.  FOURTEEN DATA SETS
C  ARE READ IN.  THESE ARE MERGED INTO ONE DATA
C  SET WHICH HAS GOOD POINTS ONLY AND WHICH CONTAINS 100 DATA POINTS
C  PER LOGICAL RECORD.  THE FINAL LOGICAL RECORD IS PADDED OUT TO 100
C  BY ADDING ZEROS.
C
C  INPUT DATA IS ON UNITS #11 - 24, AND OUTPUT ON UNIT #26.
C
C====================================================================C
C
      I = 1
      NWRITE = 0
    1 ITOT = 0
      IGOOD = 0
      K = 10+I
    2 READ(K,END=18) A
      ITOT = ITOT+1
C  INOTE = IA(18).  AN INOTE .NE. ZERO IS A BAD POINT.
      IF( IA(18) .NE. 0 ) GO TO 2
      IGOOD = IGOOD+1
      ITEMP = ITEMP+1

C  TRANSFER INFORMATION FROM A TO AA (100 POINTS PER LRECL).
      DO 4 J=1,28
    4 AA(J,ITEMP) = A(J)


      IF( ITEMP .EQ. 100 ) THEN
        ITEMP = 0
        WRITE(26) AA
        NWRITE = NWRITE+1
        GO TO 2
      ELSE
        GO TO 2
      ENDIF

   18 WRITE(6,601) I,ITOT,IGOOD,NWRITE
      IF( I.NE. 14 ) THEN
        I = I+1
        GO TO 1
      ELSE
        GO TO 22
      ENDIF
```

```
C  IF THE PROGRAM REACHES THIS NEXT LINE, THEN ALL DATA POINTS HAVE BEEN
C READ IN AND MOST OF THEM HAVE BEEN WRITTEN OUT.  FILL AA OUT TO 100
C WITH ZEROS IF NECESSARY AND WRITE OUT AA THE LAST TIME.
   22 IF(ITEMP .LE. 10)  THEN
        GO TO 25
      ELSE
        DO 24 J=ITEMP+1,100
        DO 24 I=1,28
   24   AA(I,J)=0
        WRITE(26) AA
        NWRITE = NWRITE+1
        WRITE(6,605)
        GO TO 25
      ENDIF
C
   25 WRITE(6,606) NWRITE
C ******* FORMATS ******** C
  601 FORMAT(/,5X,'ZONE # ',I2,/,5X,'TOTAL POINTS: ',I5,5X,
     @ '# GOOD POINTS: ',I5,9X,'# RECORDS WRITTEN OUT: ',I4)
  605 FORMAT(/,2X,'***** LAST RECORD HAS SOME ZEROED POINTS *****')
  606 FORMAT(///,5X,'TOTAL RECORDS WRITTEN OUT: ',I5)
C
      STOP
      END
// EXEC LINKGO,REGION.GO=1000K
//GO.FT11F001 DD DSN=XRJRR.JAN784.SIFT.DATA,DISP=SHR
//GO.FT12F001 DD DSN=XRJRR.JAN1784.SIFT.DATA,DISP=SHR
//GO.FT13F001 DD DSN=XRJRR.MAR1984.SIFT.DATA,DISP=SHR
//GO.FT14F001 DD DSN=XRJRR.JUN2084.SIFT.DATA,DISP=SHR
//GO.FT15F001 DD DSN=XRJRR.AUG2084.SIFT.DATA,DISP=SHR
//GO.FT16F001 DD DSN=XRJRR.SEP1684.SIFT.DATA,DISP=SHR
//GO.FT17F001 DD DSN=XRJRR.JAN1885.SIFT.DATA,DISP=SHR
//GO.FT18F001 DD DSN=XRJRR.MAY2385.SIFT.DATA,DISP=SHR
//GO.FT19F001 DD DSN=XRJRR.JUN1385.SIFT.DATA,DISP=SHR
//GO.FT20F001 DD DSN=XRJRR.JUN1685.SIFT.DATA,DISP=SHR
//GO.FT21F001 DD DSN=XRJRR.AUG0585.SIFT.DATA,DISP=SHR
//GO.FT22F001 DD DSN=XRJRR.SEP2985.SIFT.DATA,DISP=SHR
//GO.FT23F001 DD DSN=XRJRR.OCT2685.SIFT.DATA,DISP=SHR
//GO.FT24F001 DD DSN=XRJRR.NOV2385.SIFT.DATA,DISP=SHR
//GO.FT26F001 DD DSN=XRJRR.DMSP.FITPRP,UNIT=SYSDA,DISP=SHR
//*DCB=(RECFM=VBS,LRECL=11204,BLKSIZE=22412),SPACE=(TRK,(80,20),RLSE),
//*VOL=SER=SACC09
// EXEC NOTIFYTS
```

PROGRAM XYZTRANS ....

```
//XRJRRTRA JOB (F8002,X22,30),XYTRANS,TIME=(2,0),CLASS=E,NOTIFY=XRJRR,
//   MSGCLASS=X
//*  INPUT: DMSP DATA IN FIT FORMAT, SPACECRAFT COORDINATES (UNIT 10)
//*  OUTPUT: DMSP DATA TRANSFORMED TO GEOCENTRIC COORDINATES (11).
/*JOBPARM LINES=10
// EXEC FORTRAN,PARM='XREF'
//SYSIN DD *
      DIMENSION A(28,100)
      DIMENSION AA(28),IA(28)
      EQUIVALENCE(AA,IA)
      REAL*8 DLAT,DLON,DRA,RH(3),VH(3),ANORM(3),EFX,EFY,EFZ
C
      DRA = 3.14159265/180.0
      ICOUNT = 0
      IGOOD = 0
      NWRITE=0

C  READ DATA FROM UNIT#10.
    1 READ(10,END=22) A
      I=1
C
C  PULL OFF A VALUE FROM A, PUT INTO AA FOR PROCESSING.
    2 DO 4 J=1,28
    4 AA(J) = A(J,I)
      ICOUNT = ICOUNT+1
C  IDIR IS THE SATELLITE DIRECTION (=+ OR -1)
      IDIR = IA(20)

C  DATA QUALITY TEST
      IF( IDIR.EQ.0 .OR. IA(18).NE.0 .OR. IA(1).EQ.0 ) THEN
          GO TO 6
      ENDIF

      IGOOD = IGOOD + 1

      DLAT = AA(6)
      DLON = AA(7)
      IF(DLON .GT. 180.0) DLON = DLON-360.0

C  CALL TRANSF WITH IDIR,LAT AND LON INFORMATION, TO GET OUT
C  RH,VH AND ANORM COMPONENTS.  USE THESE TO CALCULATE THE TGS
C  MATRIX, WHICH TRANSFORMS SPACECRAFT COORDINATES TO EARTH-FIXED.
      CALL TRANSF(DLAT,DLON,RH,ANORM,VH,IDIR)

C  XI,YI,ZI ARE SPACECRAFT COORDINATES.
      XI = AA(11)
      YI = AA(12)
      ZI = AA(13)
C  TRANSFORM COORDINATES FROM SPACECRAFT TO EARTH-FIXED.
      EFX = -ANORM(1)*XI - RH(1)*YI + VH(1)*ZI
      EFY = -ANORM(2)*XI - RH(2)*YI + VH(2)*ZI
      EFZ = -ANORM(3)*XI - RH(3)*YI + VH(3)*ZI
```

```
C  TRANSFORM EARTH-FIXED COORDINATES BACK TO GEOCENTRIC X,Y,Z.
C  PUT X INTO AA(11), Y INTO AA(12), Z INTO AA(13).

      DLAT = DLAT*DRA
      DLON = DLON*DRA
      AA(11) = -DSIN(DLAT)*DCOS(DLON)*EFX - DSIN(DLAT)*DSIN(DLON)*EFY
     @         + DCOS(DLAT)*EFZ
      AA(12) = -DSIN(DLON)*EFX + DCOS(DLON)*EFY
      AA(13) = -DCOS(DLAT)*DCOS(DLON)*EFX - DCOS(DLAT)*DSIN(DLON)*EFY
     @         - DSIN(DLAT)*EFZ
C  RE-ASSIGN FLAGS
      ITEMP = IA(22)
      IA(22) = IA(24)
      IA(24) = IA(23)
      IA(23) = TEMP

C  PUT AA INTO A
    6 DO 8 J=1,28
    8 A(J,I) = AA(J)

C  WRITE OUT A IF NECESSARY.
      IF(I .EQ. 100) THEN
        WRITE(11) A
        NWRITE=NWRITE+1
      ENDIF

C  INCREMENT I, GO TO 2
      I = I+1
      IF(I .GT. 100) GO TO 1
      GO TO 2
C
   22 WRITE(6,601) NWRITE
  601 FORMAT(//,5X,'A TOTAL OF ',I4,' RECORDS WRITTEN OUT')
      WRITE(6,602) ICOUNT,IGOOD
  602 FORMAT(//,5X,'TOTAL POINTS INPUT:',I5,', WITH',I5,' GOOD POINTS')


   25 STOP
      END
C
      SUBROUTINE TRANSF(PHIR,ALAMR,RH,ANORM,VH,IDIR)
C        RH=3 COMPS OF POSITION OF SATELLITE IN (X,Y,Z) COORDS
C        ANORM=3 COMPS OF ORBIT NORMAL IN (X,Y,Z) COORDS
C        VH=RH CROSS ANORM, VELOCITY UNIT VECTOR
C        PHIR,PHIN=GEOCENTRIC LAT OF POSITION,NORMAL
C        ALAMR,ALAMN=LONG OF POSITION,NORMAL
C        IDIR=+1,0,-1 SATELLITE ASCENDING,TURNING AROUND,DESCENDING
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION RH(3),ANORM(3),VH(3)
      DATA PI/3.141592654D0/
      DTR=PI/180.D0
C  PHIN IS COMPUTED BY KNOWING THE ORBIT INCLINATION, I=98.26 FOR
      DATA PHIN/-8.74D0/
C  CHECK THAT IDIR IS NOT ZERO.
      IF(IDIR .EQ. 0) WRITE(6,601)
```

```
601 FORMAT(/,3X,'******* IDIR = ZERO. STOP EXECUTION.')
      IF(IDIR .EQ. 0) STOP
      DO 1 I=1,3
      RH(I)=0.D0
      ANORM(I)=0.D0
      VH(I)=0.D0
    1 CONTINUE
      IF(IDIR.EQ.0) WRITE(6,100) PHIR,ALAMR
  100 FORMAT(1H0,'CANNOT FIND NORMAL FOR TURNING POINT AT',2F10.2)
      IF(IDIR.EQ.0) RETURN
      ANGLE=DARCOS(-DTAN(PHIR*DTR)*DTAN(PHIN*DTR))/DTR
      IF(IDIR.EQ. 1) ALAMN=ALAMR-ANGLE
      IF(IDIR.EQ.-1) ALAMN=ALAMR+ANGLE
      RH(1)=DCOS(PHIR*DTR)*DCOS(ALAMR*DTR)
      RH(2)=DCOS(PHIR*DTR)*DSIN(ALAMR*DTR)
      RH(3)=DSIN(PHIR*DTR)
      ANORM(1)=DCOS(PHIN*DTR)*DCOS(ALAMN*DTR)
      ANORM(2)=DCOS(PHIN*DTR)*DSIN(ALAMN*DTR)
      ANORM(3)=DSIN(PHIN*DTR)
      VH(1)=-RH(2)*ANORM(3)+ANORM(2)*RH(3)
      VH(2)=-RH(3)*ANORM(1)+ANORM(3)*RH(1)
      VH(3)=-RH(1)*ANORM(2)+ANORM(1)*RH(2)
      RETURN
      END
// EXEC LINKGO,REGION.GO=500K
//GO.FT10F001 DD DSN=XRJRR.GARP,DISP=SHR
//*  TAPE 11 IS OUTPUT
//GO.FT11F001 DD DSN=XRJRR.DMSP.FITXYZ,UNIT=SYSDA,DISP=SHR            00006000
//* DCB=(RECFM=VBS,LRECL=11204,BLKSIZE=22412),SPACE=(TRK,(20,20),RLSE), 00006100
//* VOL=SER=SACC03                                                    00006200
// EXEC NOTIFYTS
```

Report Documentation Page

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15. Supplementary Notes

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16. Abstract

The DMSP F-7 satellite was an operational Air Force meteorological satellite which carried a magnetometer for geophysical measurements. The magnetometer was located within the body of the spacecraft in the presence of large spacecraft fields. In addition to stray magnetic fields, the data have inherent position and time inaccuracies. Algorithms were developed to identify and remove time varying magnetic field noise from the data. These algorithms are embodied in an automated procedure which fits a smooth curve through the data and them identifies outliers and which filters the predominant Fourier components of noise from the data. Techniques developed for Magsat were then modified and used to attempt determination of the spacecraft fields, of any rotation between the magnetometer axes and the spacecraft axes, and of any scale changes within the magnetometer itself. Software setup and usage are documented and program listings are included in the Appendix. The initial and resulting data are archived on magnetic cartridge and the formats are documented.

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